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TOMATO-SEEDLING DAMPING-OFF.

I. CONTROL BY SOIL-TREATMENT.

R. M. BRIEN and E. E. CHAMBERLAIN, Mycological Laboratory, Plant Research Station, Palmerston North.

DAMPING-OFF has for many years been a troublesome disease of tomato-seedlings throughout New Zealand, being first recorded in the Dominion by Taylor* in 1924. It is of world-wide distribution, occurring in both temperate and tropical regions.

Damping-off is caused by fungi which are carried over from season to season in the soil, so that control of the disease may be secured only by soil-treatments. The disease is a serious problem to growers who have not the facilities for steam disinfection, a process which experience has shown gives an effective control. For these growers certain chemical treatments are available. The present investigations have been carried out to determine the relative values under New Zealand conditions of the more commonly recommended treatments and to test certain new compounds.

SYMPTOMS.

Tomato-seedlings are susceptible to attack by damping-off fungi from the time the seeds germinate until some time after the plants are pricked out. When infection is severe a large number of seedlings may be attacked and killed before they reach the surface of the soil. This type of attack, known as pre-emergent damping-off, may be confused with poor germination of the seed. Frequently, however, the seedlings become infected after they emerge. In such cases the stems become constricted at or just above soil-level, and the seedlings fall over (Fig. 1). This type of infection is known as post-emergent damping-off. Less commonly, pricked-out plants several inches tall are attacked (Fig. 2).

CAUSE.

In other countries it has been found that seedling damping-off may be caused by several fungi. To ascertain the fungus responsible in New Zealand, isolations were made from specimens of infected tomato-seedlings obtained from various districts. Cultures of *Pythium ultimum* Trow.† or *Corticium vagum* Berk. *et* Curt.‡, or both, were isolated, the former being more prevalent.

* TAYLOR, W. H. (1924): *N.Z. Jour. of Agric.*, Vol. 29, pp. 40–43.

† Cultures of this fungus were kindly identified by Mr. S. F. Ashby, Director of the Imperial Mycological Institute.

‡ This strain was found to be identical with that attacking potatoes.

Experimental Method for Soil-treatments.

All experiments were carried out in the glasshouse, using a soil mixture of clay loam and silt in seed-boxes 18 in. by 12 in. and 3 in. in depth. This soil, untreated in some cases and steam-disinfected in others, was inoculated seven to ten days prior to treatment, with cultures of either *P. ultimum* or *C. vagum* grown on potato dextrose agar.

There were two types of treatments: (1) The disinfectants were applied to the soil in the form of solutions; (2) they were applied as dusts.

(1) The solutions were applied at the rate of ½ gallon per box, a quantity more than sufficient to saturate the soil, the excess liquid being allowed to drain off. In order to maintain comparable soil

FIG. 1. TOMATO-SEEDLING DAMPING-OFF.
Portion of a box of seedlings showing damping-off, caused by *Pythium ultimum*.

conditions throughout, ½ gallon of sterile water was added to all boxes not receiving treatment with chemical solutions. The treatments were carried out two to three weeks prior to sowing the seed, and, to facilitate drying, the soil was turned over at least twice during this period.

(2) The dusts were thoroughly mixed into the top half of the soil immediately before sowing.

In all experiments tomato-seed was sown in all boxes at the same time, at the rate of $\frac{1}{14}$ oz. per box. After damping-off appeared, counts of the number of infected plants were taken daily. Final counts of the number of plants left in the boxes were taken approximately five weeks after sowing, by which time they had advanced past the damping-off stage.

The following treatments were used:—

(1) *Steam Disinfection.*—Soil was placed in shallow trays in a bin and steamed for twenty minutes at a boiler pressure of 80 lb.

(2) *Formalin Solutions.* — Commercial formalin is a 40-per-cent. solution of formaldehyde. The solutions were used at concentrations of 1·25 per cent., 1 per cent., and 0·83 per cent. of formalin.

(3) *Acidulated Mercuric Chloride Solutions.*—These contained 2·5 parts by weight of concentrated hydrochloric acid solution to each

FIG. 2. TOMATO-SEEDLING DAMPING-OFF.

Plants which have become infected after pricking out. Healthy plant on right.

part of mercuric chloride. Thus a 0·1-per-cent. solution of mercuric chloride would contain 0·25 per cent. hydrochloric acid. Concentrations of 0·1 per cent. and 0·067 per cent. of acidulated mercuric chloride were employed.

(4) *Mercurous Chloride.*—This salt is almost insoluble in water, and was applied, therefore, in suspension. It was used at a concentration of 0·067 per cent.

(5) *Acetic Acid.*—This was applied as a 1-per-cent. solution.

(6) *Shirlan W.S.*—This is the trade name for sodium salicylanilide, a compound which has recently come into prominence as a fungicide. It was applied as a 0·25-per-cent. solution.

(7) *Potassium Permanganate.*—This was used as a 1-per-cent. solution.

(8) *Cheshunt Compound.*—This name is applied to a mixture of two parts by weight of copper sulphate and eleven parts of fresh ammonium carbonate. It was used as a 0·3-per-cent. solution.

(9) *Uspulun and Aretan.*—These are trade names applied to organic mercury compounds. The former was used at concentrations of 0·25 per cent. and 0·5 per cent., and the latter at 0·5 per cent.

(10) *Boiling Water.*—This was applied at the rate of 1 and 2 gallons per box of soil.

(11) *Formalin Dust.*—This consisted of a mixture of 15 parts of commercial formalin and 85 parts hydrated lime. It was applied at the rate of 1½ oz. per box.

(12) *Brassisan Dust.*—"Brassisan" is the trade name for an organic mercury compound. It was applied as a dust at the rate of ⅛ oz. per box.

Experimental Results.

Experiment I: Control of P. ultimum and C. vagum.

This, a preliminary experiment, was carried out in the spring of 1934, using farm soil which was not steam-disinfected before inoculating with cultures of the fungi. The treatments employed were as follows: Steam disinfection; formalin, 1·25 per cent. solution; potassium permanganate, 1 per cent. solution; Cheshunt compound, 0·3 per cent. solution; acidulated mercuric chloride, 0·1 per cent. solution; "Uspulun," 0·25 per cent. solution, and formalin dust, 1½ oz. per box. In addition, uninoculated untreated and inoculated untreated soils were included in the experiment. All boxes, two for each treatment, were sown with tomato-seed (variety Kondine) on 19th August, 1934. Unfortunately, the germination of this line of seed was poor, giving only 70 per cent. in ten days.

(*a*) Results on control of *P. ultimum:* The germination was good in the soil treated with steam and formalin, fair with Uspulun and formalin dust, and poor with potassium permanganate, Cheshunt Compound, and in the inoculated and uninoculated untreated boxes. In the formalin treatment the germination was slightly delayed, while the acidulated mercuric chloride caused severe injury to the seed. Damping-off occurred in all boxes except those treated with steam and formalin solution. Partial control was obtained with Uspulun and formalin dust, but the other treatments gave no control.

(*b*) Results on control of *C. vagum:* As in the above, complete control of damping-off was obtained only in the steam and formalin treated soils. Isolations from infected plants in the uninoculated untreated soil yielded cultures of *P. ultimum*, hence from the treatments other than steam and formalin, the results, in relation to the control of *C. vagum*, were confused by the presence of *Pythium*.

Experiment II: Control of P. ultimum.

The soil in this series was steam-treated before adding cultures of *Pythium*, in order to destroy other fungi already present. All boxes were sown on 25th October, 1934, with the variety Somner's Early Longkeeper. This line of seed gave a germination test of 91 per cent. in ten days.

Table I.—Results of Experiment II: Treatments applied to Steam-disinfected Soil inoculated with Pythium ultimum.

Treatment.	Number of Plants emerged.	Percentage of Plants damped-off.*		Average per Cent. Plants damped-off.
		Pre-emergent.	Post-emergent.	
Steam disinfection ..	Box A=603	0	0	0
	Box B=592	0	0	0
Formalin, 1·25 per cent. solution	Box A=568	0	0	0
	Box B=615	0	0	0
Formalin, 0·83 per cent. solution	Box A=283	52	17	76
	Box B=247	58	25	..
Formalin dust, 1½ oz. per box	Box A=378	36	7	31·5
	Box B=506	14	4	..
Boiling water, 1 gallon	Box A= 51	91	5	96
Boiling water, 2 gallons	Box A=240	40	26	66
Acidulated mercuric chloride, 0·067 per cent. solution	Box A= 23	Seed injury†	3	..
Uninoculated, untreated	Box A=589	0	0	0
	Box B=571	0	0	..
Inoculated, untreated	Box A= 11	98	1	99·5
	Box B= 5	99	1	..

* The total number of plants which germinated in the steam-sterilized soils were averaged and this figure taken as the average germination per box. All percentages were based on this average figure, pre-emergent damping-off being obtained by the difference between this figure and the number of healthy plants plus the number which showed post-emergent damping-off.

† The term "seed injury" in this and the following tables is applied to those treatments which depressed germination. In such cases it was not possible to calculate the percentage of pre-emergent damping-off.

Experiment III: Control of P. ultimum and C. vagum.

In this experiment damping-off fungi were added to both steam-disinfected and untreated soils. All boxes were sown on 14th June, 1935, with seed of the variety Sutton's Best of All. This seed had been saved from the current season's crop and gave a germination test of 99 per cent. in ten days.

Table II.—Results of Experiment III : Treatments applied to both Steam-disinfected and Untreated Soil inoculated with Pythium ultimum.

Treatment.	Number of Plants emerged.	Percentage of Plants damped-off.		Average per Cent. Plants damped-off.
		Pre-emergent.	Post-emergent.	
Steam-disinfected Soil.				
Steam disinfection ..	Box A=506	0	0	0
	Box B=532	0	0	
Formalin, 1·25 per cent. solution	Box A=526	0	0	0
	Box B=502	0	0	
Formalin, 1 per cent. solution	Box A=520	0	0	0
	Box B=416	0	0	
Formalin, 0·83 per cent. solution	Box A=512	0	0	0
Acidulated mercuric chloride, 0·1 per cent. solution	Box A = 4	Seed injury	0	..
Acidulated mercuric chloride, 0·067 per cent. solution	Box A=128	Seed injury	2	..
	Box B=192	Seed injury	2	
Mercurous chloride 0·067 per cent. suspension	Box A=215	Seed injury	21	..
	Box B=335	Seed injury	18	
Acetic acid, 1 per cent. solution	Box A=483	7	6	10
	Box B=496	5	2	
Uninoculated, untreated	Box A=504	0	0	0
Inoculated, untreated	Box A=211	59	35	82
	Box B=370	29	41	
Untreated Soil.				
Formalin, 1·25 per cent. solution	Box A=513	0	0	0
	Box B=537	0	0	
Formalin, 0·83 per cent. solution	Box A=534	0	0	0
	Box B=530	0	0	
Acidulated mercuric chloride, 0·067 per cent. solution	Box A = 83	Seed injury	0	..
	Box B = 33	Seed injury	0	
Inoculated, untreated	Box A=323	38	34	72
	Box B=347	33	39	
Uninoculated, untreated	Box A=312	40	29	71·5
	Box B=292	43	31	

Table III.—Results of Experiment III : Treatments applied to both Steam-disinfected and Untreated Soil inoculated with Corticium vagum.

Treatment.	Number of Plants emerged.	Percentage of Plants damped-off.		Average per Cent. Plants damped-off.
		Pre-emergent.	Post-emergent.	
Steam-disinfected Soil.				
Steam disinfection	Box A=506	0	0	0
	Box B=532	0	0	
Formalin, 1·25 per cent. solution	Box A=518	0	0	0
	Box B=511	0	0	
Formalin, 1 per cent. solution	Box A=522	0	0	0
	Box B=529	0	0	
Formalin, 0·83 per cent. solution	Box A=463	11	2	13
Acidulated mercuric chloride, 0·1 per cent. solution	Box A = 6	Seed injury	0	0

Table III—continued.

Treatment.	Number of Plants emerged.	Percentage of Plants damped-off.		Average per Cent. Plants damped-off.
		Pre-emergent.	Post-emergent.	
Steam-disinfected Soil—continued.				
Acidulated mercuric chloride, 0·067 per cent. solution	Box A=418	Seed injury	0	..
	Box B=329	Seed injury	0	
Mercurous chloride, 0·067 per cent. suspension	Box A=369	Seed injury	0	..
	Box B=387	Seed injury	0	
Acetic acid, 1 per cent. solution	Box A=518	0·4	3	4·7
	Box B=514	1·0	5	
Uninoculated, untreated	Box A=504	0	0	0
Inoculated, untreated	Box A=460	12	15	33
	Box B=487	6	33	
Untreated Soil.				
Formalin, 1·25 per cent. solution	Box A=540	0	0	0
	Box B=541	0	0	
Formalin, 0·83 per cent. solution	Box A=502	0	0	0
	Box B=502	0	0	
Acidulated mercuric chloride, 0·067 per cent. solution	Box A= 46	Seed injury	0	0
	Box B= 55	Seed injury	0	
Inoculated, untreated	Box A=254	51	25	79
	Box B=303	42	40	
Uninoculated, untreated	Box A=312	40	29	71·5
	Box B=292	43	31	

Experiment IV: Control of P. ultimum.

Soil treatments were carried out with farm soil which was not steam-treated prior to the addition of cultures of the fungus. All boxes were sown on 5th September, 1935, with the same line of seed as that used in Experiment III.

Table IV.—Results of Experiment IV: Treatments applied to Untreated Soil inoculated with Pythium ultimum.

Treatment.	Number of Plants emerged.	Percentage of Plants damped-off.		Average per Cent. Plants damped-off.
		Pre-emergent.	Post-emergent.	
Steam disinfection ..	Box A=469	0	0	0
	Box B=463	0	0	
Formalin, 1·25 per cent. solution	Box A=475	0	0	0
	Box B=498	0	0	
Shirlan, W. S., 0·25 per cent. solution	Box A=359	25	7	46
	Box B=286	40	20	
Uspulun, 0·5 per cent. solution	Box A=201	Seed injury	2	..
	Box B=127	Seed injury	1	
Aretan, 0·5 per cent. solution	Box A=137	Seed injury	4	..
	Box B=232	Seed injury	11	
Brassisan, $\frac{1}{6}$ oz. per box	Box A=247	40	13	55
	Box B=259	38	19	
Inoculated, untreated	Box A=269	36	16	54
	Box B=272	35	21	
Uninoculated, untreated	Box A=350	27	21	53
	Box B=344	27	30	

Discussion of Results.

In general it was found that damping-off became more severe in soil which had been steam-disinfected before being inoculated with the damping-off fungi (Fig. 3). Also it would appear from the effect of acidulated mercuric chloride on *Pythium* (Experiment III, Table II), and the effect of formalin 0·83 per cent. on *Corticium* (Experiment III, Table III), that damping-off was more easily controlled in untreated soil than in steam-disinfected soil.

(1) *Steam Disinfection.*

Complete control of damping-off was obtained in all cases where this process was adopted. No injurious effect on germination was observed (Figs. 3 and 4).

(2) *Formalin.*

(*a*) 1·25 per Cent. Solution: This concentration gave complete control of both *Pythium* and *Corticium* (Figs. 4 and 5). In Experiment I this treatment caused slight delay in germination of the seed. This was attributed to the fact that insufficient time had elapsed between treating and sowing, and thus all the formaldehyde had not evaporated from the soil.

(*b*) 1 per Cent. Solution: Used only in Experiment III, this concentration gave results comparable with the 1·25-per-cent. solution for the control of both fungi. Further tests with this concentration are necessary before it can be recommended.

(*c*) 0·83 per Cent. Solution: In Experiment II this concentration failed to control *Pythium* (Table I, Fig. 4). In Experiment III it appeared to control *Pythium*, but failed to combat *Corticium* growing in steam-disinfected soil (Tables II and III). This concentration cannot be relied upon to give control of either organisms.

(*d*) Formalin Dust: This product was used to combat *Pythium* in Experiments I and II. Although it reduced the amount of disease in each case, effective control was not secured (Table I, Fig. 5). Formalin dust cannot, therefore, be recommended.

(3) *Acidulated Mercuric Chloride.*

(*a*) 0·1 per Cent. Solution: At this concentration it caused severe injury to the seed completely inhibiting germination in Experiment I and reducing it to 1 per cent. in Experiment III.

(*b*) 0·067 per Cent. Solution: This concentration was used in Experiments II and III, resulting in injury to the seed in both instances. In Experiment II (*Pythium*) only 4 per cent. of the seed germinated, and of these a number damped-off (Table I). In Experiment III the germination was somewhat better, ranging from 6 per cent. in one box to 80 per cent. in another. Although under the conditions of the experiment it appeared to give complete control of *Corticium* and *Pythium* in soil not steam-treated, it failed to control *Pythium* in steam-disinfected soil (Tables II and III).

From these results it is evident that acidulated mercuric chloride solutions, even at concentrations which cause severe injury to the seed, do not give economic control of damping-off due to *P. ultimum*.

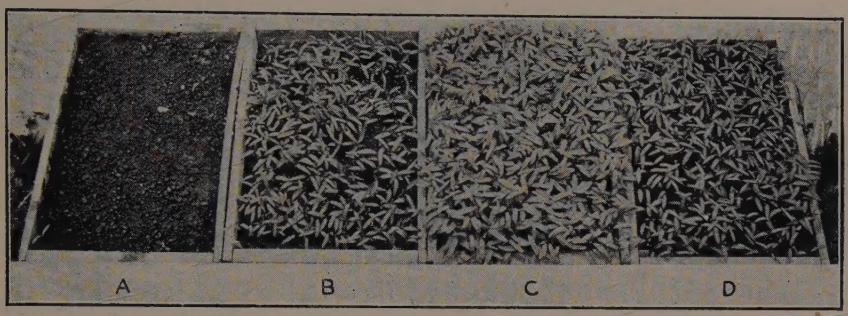

FIG. 3. EFFECT OF SOIL TREATMENTS ON TOMATO-SEEDLING DAMPING-OFF.

A—Steam-disinfected soil inoculated with *Pythium ultimum*. B—Untreated soil inoculated with *P. ultimum*. C—Steam-disinfected soil inoculated with *P. ultimum* and then again steam-disinfected. D—Steam-disinfected soil inoculated with *P. ultimum* and then treated with a 1-per-cent. solution of acetic acid.

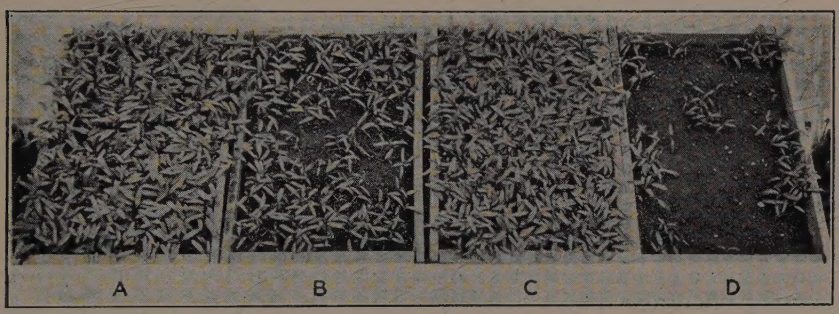

FIG. 4. EFFECT OF SOIL TREATMENTS ON TOMATO-SEEDLING DAMPING-OFF.

All four boxes contained steam-disinfected soil which had been inoculated with *Pythium ultimum*.

The treatments applied to this soil were as follows: A—Steam disinfection; B—Mercurous chloride, 0·067 per cent. suspension; C—Formalin, 1·25 per cent. solution; D—Formalin, 0·83 per cent. solution.

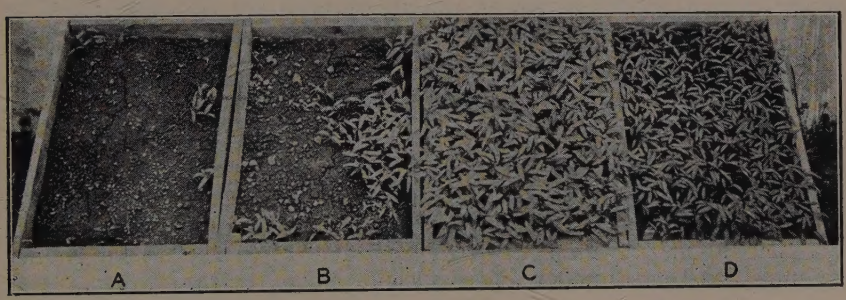

FIG. 5. EFFECT OF SOIL TREATMENTS ON TOMATO-SEEDLING DAMPING-OFF.

All four boxes contained steam-disinfected soil which had been inoculated with *Pythium ultimum*.

The treatments applied were as follows: A—Boiling water, 1 gallon; B—Boiling water, 2 gallons; C—Formalin, 1·25 per cent. solution; D—Formalin dust.

(4) *Mercurous Chloride, 0·067 per Cent. Suspension.*

This treatment was used only in Experiment III, where it caused injury to the seed, with a resultant poor and delayed germination (Tables II and III, Fig. 4). It controlled damping-off caused by *Corticium*, but failed to control *Pythium*.

(5) *Acetic Acid, 1 per Cent. Solution.*

This also was tested in Experiment III, but gave only partial control of both damping-off fungi (Tables II and III, Fig. 3).

(6) *Boiling Water.*

Treatments with boiling water were carried out in Experiment II. Applied at the rate of 1 and 2 gallons per box, it failed to control *Pythium* (Table I, Fig. 5).

(7) *Cheshunt Compound, 0·3 per Cent. Solution.*

This treatment failed to give any control of *Pythium*.

(8) *Potassium Permanganate, 1 per Cent. Solution.*

This treatment, tested in Experiment I, failed to give control of *Pythium*.

(9) *Organic Mercury Compounds.*

Uspulun 0·25 per cent. solution in Experiment I and 0·5 per cent. solution in Experiment IV, Aretan 0·5 per cent. solution in Experiment IV, and Brassisan dust (applied at the rate of $\frac{1}{8}$ oz. per box) in Experiment IV were used for the control of *Pythium*. All treatments had a depressing effect on germination and failed to control damping-off (Table IV).

(10) *Shirlan W.S., 0·25 per Cent. Solution.*

This solution applied to *Pythium* inoculated soil failed to control the disease.

Recommendations.

In dealing with a disease such as damping-off, where infection may under certain conditions spread rapidly through the soil from plant to plant, it is necessary that any treatment applied should give complete control of the disease. Thus, of the treatments tested, only two can be recommended—namely, steam-disinfection and the application of 1·25 per cent. formalin solution.

Steam Disinfection.

Where the facilities are available, this is undoubtedly the most convenient method of treating large quantities of soil for the control of damping-off. A temperature of from 180° F. to 200° F. for twenty minutes has been found to give efficient control of the disease.

Formalin, 1·25 per Cent. Solution.

Where steaming facilities are not available formalin treatment may be employed. The soil should be saturated, and the excess solution drained off. The soil should then be allowed to stand, with occasional

forking over to assist in drying, until all the formalin has disappeared. The formaldehyde has all evaporated when its pungent odour can no longer be detected. This takes at least two weeks.

After both treatments care should be taken to avoid recontamination of the soil.

SUMMARY.

(1) Tomato-seeding damping-off in New Zealand has been shown to be caused by the fungi *Pythium ultimum* and *Corticium vagum*.

(2) *P. ultimum* was found to be of greater incidence and to cause more severe injury than did *C. vagum*.

(3) A number of soil treatments were tested out and the results tabulated.

(4) It has been shown that damping-off is more severe and more difficult to control in soil which has been steam-disinfected before fungous cultures have been added to it.

(5) Steam disinfection and treatment with formalin, 1·25 per cent. solution, are recommended for the control of damping-off.

PAMPAS GRASS (*CORTADERIA SELLOANA*) AS FODDER.

RECENT INVESTIGATIONS.

B. C. ASTON and R. E. R. GRIMMETT, Chemistry Section, Department of Agriculture.

SINCE the article on "Pampas Grass as Winter Cow-feed" appeared in the May, 1934, issue of the *Journal* some progress has been made in investigating both the chemical and the cultural aspects of this plant, the correct botanical name for which (*Cortaderia selloana*) we are indebted to the Director of the Royal Gardens, Kew (Sir A. W. Hill, F.R.S.).

A paper by F. B. Shorland, Analyst, Chemistry Section, in the December, 1935, issue of the *New Zealand Journal of Science and Technology* deals with the chemical composition of mature leaves and the succulent leaf bases of pampas. He found that pampas herbage contains about 40 per cent. of cellulose, 19 per cent. to 24 per cent. of hemicellulose, and 17 per cent. of lignin, besides 7 per cent. to 10 per cent. each of ash and protein. The large amount of cellulose, which is 50 per cent. to 100 per cent. higher than in common pasture plants, together with the hemicellulose, sugars, &c., make this predominantly a carbohydrate fodder. The lignin, which is present to about the same extent as in ordinary grasses, is usually considered quite indigestible, but according to Woodman and Stewart it also has an adverse and variable effect on the digestibility of the other constituents.

Lignin occurs in intimate association with cellulose, these constituting together the greater part of the fibre or cell-wall constituents, and lignin, being itself indigestible, exerts a protective effect against the action of digestive juices on the remainder of the tissues. Where, however, as in pampas, the same amount of lignin is spread over a much larger amount of cellulose, the protective action of the lignin will be diminished.

In ruminants the digestion of fibre is carried out by bacteria in the rumen and other parts of the alimentary canal, which break it down into sugars, organic acids, and gases. The sugars and organic acids are assimilated to a varying degree while the gases escape, but on the basis of feeding-trials it has been found that cellulose has a feeding-value equal to starch.

The fineness of the fibre in pampas and the brittleness of the leaves doubtless contribute to its evident high digestibility. Preparations of crude fibre made from average-quality hay and from pampas showed the pampas fibre to be very soft and fine compared with that from hay which contained many harsh lignified fragments.

Pampas contains only about 10 per cent. of protein, but this is probably of good quality, being part of the substance of the living-cell contents and not a reserve or waste product, both of which classes of nitrogenous materials in other plant-foods, such as tubers and seeds, are frequently of unbalanced composition or sometimes, in quantity, injurious.

It would appear from these considerations that as supplementary fodder, the feeding-value of the dry matter of pampas-grass would be greater than that of average-quality hay, especially when used in conjunction with heavily top-dressed pastures. Early spring pasture-growth is rich in proteins and minerals, but is poor in dry matter, and in carbohydrate or "energy food." Top-dressed pastures in the Waikato, for instance, frequently have more than 30 per cent. protein in the dry matter, which if fed by itself is wastefully rich, especially at a season when carbohydrate is required for heat-production in cold weather.

In contrast to such crops as turnips, kale, or pumpkins, pampas is available whenever required, and does not, when established, deteriorate as other supplementary tall crops do by lodging in high winds or heavy rains. Its requirements in regard to surface-soil moisture, soil texture and fertility, and climatic conditions are less circumscribed, and its culture, when established, much simpler. It is a mistake to suppose that pampas is suited only to inferior-quality soil. The soil of the Hauraki Plains is one of the richest in New Zealand, and that of Kaharoa one of the poorest pumice. Pampas is doing well and is palatable to stock on both types of soil. Pampas does not require fertilizer—indeed, it is suggested by some experiments that fertilizer even does harm. In the growth of pampas only one anxiety need trouble the farmer—that arising from the suspicion that his fences are hardly strong enough to resist the great desire of stock to break them down in order to get at the young pampas. Many instances have shown that uncontrolled grazing by cattle will kill out the clumps of pampas.

It is suggested that pampas will be found useful in stump country, where ploughing is impossible and often soft-fodder crops cannot be grown. The use of pampas may, therefore, considerably shorten the time taken to break in bush land to dairy-farming by the present practice of felling the forest, burning off, surface-sowing the grass, allowing the stumps to rot, which takes twenty or more years, before logging-up and burning the stumps, ploughing and growing supplementary fodder crops. (Fig. 1.)

The authors do not consider it proved that any variety of pampas is unpalatable. Of course, an overgrown plant many years old may present physical difficulty to grazing by stock unless first cut down

FIG. 1. GROWTH IN DECEMBER AT FRANKTON JUNCTION OF PAMPAS GRASS WHICH WAS FED-OFF IN WINTER.

FIG. 2. PAMPAS GRASS NEAR HAMILTON.

and allowed to form new growth, while stock unused to pampas may not immediately attack a plant unless encouraged to do so.* The season of the year and the condition and nature of the pasture forming the bulk of the grazing for the stock also need to be taken into account.

For instance, at Whangarei on the large estuarial reclamation near the town, where seedling pampas covers an area of several acres, and whence already upwards of 100,000 plants have been removed for replanting without noticeable thinning of the stand, a few cows or calves are apparently grazed intermittently. Such a large surplus of pampas fodder is available that only a bush here and there is considerably grazed, the rest being only nibbled, while a very small proportion of clover and other grasses between the pampas is more freely eaten. Were enough stock put on to cope with the growth of pampas, there is little doubt that every bush would be grazed down, and it is stated on reliable authority that this has happened on several occasions to more than one area of seedling pampas on the reclaimed mud-flats, the pampas being killed right out by continual grazing.

Further proof of the general palatability of unselected pampas is afforded by a plantation of 4 acres near Hamilton, which the owner stated was obtained from various old clumps existing (for ornamental purposes) in gardens of the surrounding district. Of the three breaks into which the stand is fenced, two had been grazed this winter. Every plant appeared to have been eaten right down to the crown and a vigorous new growth re-established. Fig. 2 shows on left of fence the ungrazed break, and on right the grazed break with new growth. The owner stated that the cattle "wolfed" the pampas, and showed no evidence that any plant was unpalatable.

The authors would be pleased to receive any root cuttings of pampas which is definitely thought to be unpalatable. They very much doubt if such exists. Cultivated pampas should be prevented from flowering, which diminishes the vitality of the plant.

On a property near Frankton an extensive experiment with the object of comparing pampas of various origins is being carried out by a farmer. Seedlings from Whangarei, as well as root cuttings from three different sources, have been planted in adjacent strips. The Whangarei seedlings, after dying back to the ground, are making vigorous new growth, but it was noticeable that in many cases the plants had been grazed back, presumably by rabbits or hares, as larger animals were excluded.

Several other plantations of seedlings, including one near Waipawa, Hawke's Bay, on river silt, showed the same characteristic of dying back to the crown before putting up new growth†. This does not always happen, however, especially if the seedlings are under about 6 in. in height, as a number of tiny seedlings transported to Wellington have made vigorous growth without suffering check. (See Fig. 3.)

* Stock are often very shy in taking to a strange food, even although it may be one well recognized in other districts and of good nutritive value.

† Planted in October, 1935, when seen early in December these seedlings, in most cases, had only a small green top appearing among the dead leaves. When revisited during the second week in April, 1936—*i.e.*, four months' growth—an amazing change had occurred. Many of the plants had developed into tussocks or clumps over a foot in diameter at the base, with a score or more of shoots having leaves up to 6 ft. long. These plants appeared able to well withstand grazing the first winter after planting.

Over 70 per cent. of seed collected at Whangarei and raised in Wellington germinated, and the seedlings, planted out when about 4 in. to 6 in. high, have made continuous growth.

For any one desiring to make extensive plantations of pampas, wild seedlings or seed (when commercially available) should provide the most economical and most certain method. Seed is best raised in a box in gentle heat, using very sandy soil, so that the fine roots can be shaken out without damage. The seed should be germinated on the surface and not covered by soil. If the ground were well cultivated and freed from weeds, it would seem that the most rapid establishment would

FIG. 3. PAMPAS PLANTS NINETEEN MONTHS FROM SEEDLINGS.

result from planting the seedlings out directly from the seed-box, when a few inches high, but otherwise, if grown-on for a season in a nursery bed, they should be moved to their permanent positions as rapidly and with as little disturbance of the roots as possible.

Pampas root-cuttings should be planted with the above-ground stem at an angle of 45° with the surface, so that water and frost affect the butt less than if planted at a right angle with the surface. Drought is a great enemy to the establishment of pampas, and it is unfortunate that the drought of 1934–35 summer caused so many failures in attempts to establish plantations by means of root-cuttings in Hawke's Bay and Manawatu districts.

Discussion and Summary.

Accepting as true that there is no such thing as unpalatable pampas, the refusal upon occasion of cattle to eat pampas being capable of explanation on grounds other than that of palatableness, the very best

method for any farmer to adopt is to raise his own seedlings and plant them out in a well-fenced enclosure before the critical period in the growth of the seedling arrives at which on transplanting it dies down to the root. That this may be done has been amply demonstrated in laboratory and in garden by the authors. Seed threshed out of Whangarei pampas-plumes has given a 72-per-cent. germination test, and when the seed is merely laid on the surface instead of being covered with the soil a good braird results. Therefore the ideal way for the farmer to establish a pampas plantation of some acres would be to have the paddock which is the site of the plantation ready for the reception of the seedlings when they are sufficiently strong to be planted out 6 ft. apart or approximately at the rate of 1,000 plants per acre. This should be in the late spring or early summer, the exact time depending on local climatic conditions which, of course, may vary from season to season. The paddock must be securely fenced off. Should stock gain access they will graze and destroy the young plants in spite of abundance of other feed in the vicinity. The soil should be well worked, in good tilth, and free from weeds, and must be kept so until the seedlings are sufficiently advanced in growth to compete with the weeds, which, once the pampas is established, will speedily be crowded out. Thereafter no anxiety need trouble the farmer as to noxious weeds such as ragwort, &c., as the pampas will overshadow them.

Under favourable conditions, especially as regards soil-moisture, young plants will make rapid growth. After the first grazing, which will not be earlier than some time in the second year after planting out, the portion grazed must be shut up, and the growth from the butts will be extremely rapid.

In mid-summer in a Karori (Wellington) garden a row of plants in their second year had to be cut back to the ground as they were shading the adjoining plants excessively; twenty plants yielded 25 lb. of green matter. Three months later is was again necessary to cut the row of seedlings to ground level, the weight given being 23 lb. The cut stems continued to grow so that in an hour's time a difference in the stem from flatness to convexity could clearly be seen, and in a week's time there was 8 in. of yellow-green leaf, which in the following fortnight gained the usual green colouring of the plant. Statements that the plant will grow 1 ft. a month after grazing are therefore well within the mark. A photograph taken one calendar month after cutting in mid-summer shows fully 2 ft. of growth in the month.

The advice to work with the youngest possible seedlings in establishing a plantation is not given without experience. Every time one of the authors has visited Whangarei a batch of tiny wild seedlings has been brought back to Wellington, and these when planted out have all taken at once to their new environment, surviving without mortality or appreciable check in growth. On the other hand, the planting-out of clumps of the mature tussock subdivided to ensure that a portion of root is present often results in high mortality. This is especially the case when a droughty summer follows the planting as unfortunately was the case in Hawke's Bay and Manawatu districts during the summer of 1934–35, which prejudiced many farmers against pampas. In all probability had seedlings instead of subdivisions of the mature plant been planted out, and the usual precautions exercised, all the plants would have survived, as they did in Wellington during the same droughty

summer. Farmers must be particularly warned against assuming that because the above-ground portion of the plant is dead the roots also are dead. *A dead appearance of the young plant or root-cutting may persist for six months and yet finally green shoots develop from the roots.*

The difficulty of obtaining supplies of seed has yet to be overcome, but what has been done on a laboratory scale will doubtless be achieved on a manufacturing scale as soon as the demand arises. At present only uncleaned seed is obtainable from the English seed house of Sutton and Sons, Reading, at 12s. 6d. per pound, and the supply, even of this, is limited. Dobbie and Co., Edinburgh, also sell packets of seed. There is some evidence that cleaned seed—*i.e.*, seed freed from the surrounding chaffy matter—decreases rapidly in germinating-capacity, so that there may be a good reason for importing uncleaned seed if it has to be imported. Wild seedlings are obtainable from Whangarei by the courtesy of the secretary of the Whangarei Harbour Board, to whom inquiries should be addressed, at 30s. per thousand f.o.b. or f.o.r., Whangarei. The seedlings are packed and forwarded under the superintendence of a skilled nurseryman.

The behaviour of the pampas-plants other than mere seedlings is extraordinary for a grass or even an evergreen plant. Usually one may expect the whole of the above-ground portion to die right back and the dead leaves to remain for several months; finally a shy green growth appears in the clump of dead leaves, and this new growth gradually strengthens until the plant is thoroughly established. The danger is that farmers, seeing nothing but dead leaves persisting for months in their plantations, may wrongly assume that the whole plant is dead and plough the site up again, or may even allow the weeds to take charge, stifling out the young growth.

Mr. C. R. Taylor, in charge of the experiments at Rotorua, reports that if extreme care be taken not to disturb the roots quite large plants raised from seed may be transplanted without dying back, and suggests that if seedlings are grown in an enclosure adjoining the paddock to contain the pampas plantation it may be possible to obtain much better results by transplanting with the minimum of disturbance to the roots. The advantage of using plants derived from seed or wild seedlings over plants raised from subdivisions of old clumps is that the last kind of plants do not stool out quickly enough and are therefore, in this respect, inferior to seedlings, which make early and rapid growth in all directions and so help to smother weeds, which in the first year are such a menace to the young pampas-plants spaced 6 ft. apart. (Fig. 4.)

Conclusions.

Pampas plantations are best raised from seed germinated in shallow boxes on the surface of a light, sandy soil such as pumice, transplanted to a well-tilled soil, and when they are about nine months old planted out in a strongly fenced cultivated area at the rate of 1,000 plants to the acre—that is, in rows so that a plant is approximately 6 ft. from any other plant. They must not be grazed until near the end of the second year after being established in the paddock. During this time the land should be kept free from weeds. After this the pampas-plants will look after themselves and successfully compete with the weeds.

FIG. 4. PAMPAS-GRASS SEEDLINGS PLANTED IN THE AUTUMN, 1935, AND PHOTOGRAPHED THE FOLLOWING MID-SUMMER.

FIG. 5. PAMPAS SEEDLINGS, SIX MONTHS OLD, RAISED FROM WHANGAREI SEED. There are great variations in the seedlings, all of the same age.

The next best method is to obtain the *smallest possible wild seedlings* from Whangarei and plant these out in the site of the required plantation. Seedlings may be planted in spring and autumn.

The most precarious method of establishing a plantation is by means of subdivisions of existing mature clumps, as, owing to the danger of a drought killing the cuttings, heavy mortality may be experienced. Such cuttings should be obtained from vigorous shoots, and should not be taken from portions that have borne flowers ; the outside portions of a clump supply the best shoots. Cuttings should be planted in spring, when danger of frost is over and when the soil is moist. Cuttings must be planted at an angle of 45 degrees with the surface : if planted upright, water may rot the crown. Pampas is a sun-loving plant—a light-demander. It must be kept free from smothering-weeds in the early days of establishment.

With regard to all plantations, stock must not be allowed to graze the plants too hard during the first grazing, neither must the plants be allowed to flower, as this would considerably weaken the vegetative development of the whole plant. It is unnecessary to manure pampas unless unsatisfactory results indicate that some form of soil-enrichment is necessary.

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CONTROL OF RUSHES BY MOWING.

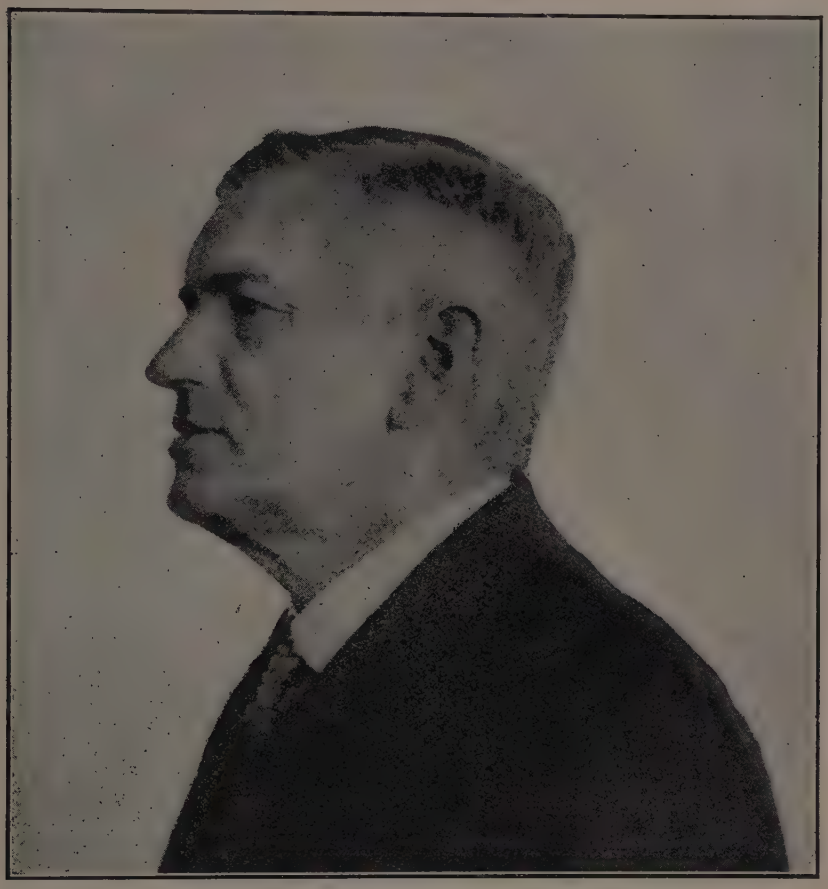
The following statement by Mr. E. C. Holmes, Te Hopai, Featherston, describes instructive experience :—

" I was much interested in the advice about rush-control on page 49 of the January, 1936, *Journal*. I farm on the wet lands bordering Lake Wairarapa. Some seven years ago I began to mow my rushes, which over many acres were so dense and high that a horse could hardly get through them, let alone sheep. To-day the rushes are reduced to small weedy clumps, hollow in the centre. None of the land has proper drainage, nor can it be got. This land now carries three to four ewes to the acre. I mow some 600 acres to 800 acres a year. Several paddocks now have to be mown only every second year, and, again, in some places the rush has disappeared. I like to mow when the seed is fully developed : the young second growth that comes in the autumn the cattle will nip off in the winter, and so one gets a second cut free of cost. If possible, I top-dress after cutting : top-dressing encourages the stock to eat the rush, but obstinate cases I cut in December and again in March. I am careful to leave shelter-belts for use in lambing. I have had heavy losses with spring lambs through completely ' cleaning up ' the paddock. In my particular case rush-mowing has been a great success, and is part of the farm routine work."

DR. C. J. REAKES ADDRESSING A RECENT GATHERING OF FARMERS AT WALLACEVILLE VETERINARY LABORATORY.

RETIREMENT OF DR. C. J. REAKES, DIRECTOR-GENERAL OF AGRICULTURE.

AFTER thirty-nine years as a member of the staff of the Department of Agriculture, C. J. Reakes, Esq., C.B.E., D.V.Sc., M.R.C.V.S., retired on 30th April, 1936. During the latter eighteen years of his term of service he guided the destinies of the Department as its Permanent Head.



C. J. REAKES, C.B.E., D.V.SC., M.R.C.V.S.

In the House of Representatives the Minister of Agriculture, the Hon. W. Lee Martin, in announcing that Dr. Reakes had tendered his resignation, expressed on behalf of the Government its deep appreciation of the successful manner in which Dr. Reakes had carried out his duties, and paid a tribute to his zeal, courtesy, and devotion to duty. The remarks of the Minister were endorsed by the Right Hon. G. W. Forbes, leader of the Opposition.

After a distinguished scholastic career and considerable professional experience overseas, Dr. Reakes arrived in New Zealand from England in 1897, and was appointed to the Department of Agriculture as a veterinary surgeon. In 1901 Dr. Reakes was appointed Assistant Chief Veterinarian.

When the Veterinary Laboratory was established at Wallaceville it became the centre for the veterinary research work of the Department and headquarters of the Veterinary Division. In January, 1909, Dr. Reakes was appointed Chief Veterinary Surgeon in succession to Dr. Gilruth, who resigned to take up a position in Australia. Dr. Reakes at the same time succeeded Dr. Gilruth as Director of Veterinary Services in the Defence Department.

In 1910 Dr. Reakes was granted the degree of Doctor of Veterinary Science by the University of Melbourne, and when the Department was reorganized during this year he was promoted to the position of Director of the Live-stock Division.

On the outbreak of war in 1914 Dr. Reakes devoted his services to the work of the Defence Department in connection with the purchase of remounts, the supervising of fodder-supplies, and the transport for the horses. Later he was associated with the requisition of meat, wool, dairy-produce, and other supplies for the British Government. In 1919 he was created C.B.E. (Military Division).

In more recent years Dr. Reakes twice visited Great Britain officially in connection with the frozen-meat industry and agricultural research, attending conferences in London.

On 30th April last a large gathering of officers of the Department of Agriculture, with many others, took farewell of Dr. Reakes, when the Minister of Agriculture, the Hon. Mr. W. Lee Martin, made a presentation on behalf of the Department to Dr. and Mrs. Reakes. The Minister made reference to the reliability and grip of his work possessed by Dr. Reakes as Director-General, and pointed out that when Dr. Reakes joined the Department the staff totalled only 106, whereas it was now 529.

Mr. A. H. Cockayne, who presided, supplemented the remarks of the Minister in giving tribute to Dr. Reakes, and commented that his period as Director-General coincided with unparalleled expansion of the Dominion's agricultural activities.

The industry, tact, courtesy, and good will of Dr. Reakes are well known to and appreciated by the farming and business communities of New Zealand, all sections of which will join with the staff of the Department of Agriculture in wishing him many years of well-earned leisure.

—*Wm. C. Robinson.*

CRITICAL STUDY OF IMPORTANT FACTORS IN SUCCESSFUL PIG-KEEPING.

ANALYSIS OF LITTER RECORDS OF THE MANAWATU-OROUA PIG DEVELOPMENT AND RECORDING CLUB FOR THE YEARS 1932-35.

C. P. McMeekan, Massey Agricultural College, Palmerston North.

In the first annual report of the club in 1933(1) an analysis of the litter records completed during the first year of operation was presented. This provided valuable data as to the varying standards of productive efficiency of the herds and individual breeding-stock of recording members, together with some information as to the most important factors

associated with good results. Unfortunately, the limited number of litters upon which the investigation necessarily was based limited also the information derived; the work of the past two seasons, however, has made available some 300 additional litter records, and has provided the material for a more comprehensive and reliable study of some of the factors of importance in successful pig-raising.

Table 1.—Summary of Litter Averages.

Period ending	Number of Litters	Average Number per Litter.			Mortality.		Average Litter-weights in Pounds at			
							Twenty-one Days.		Fifty-six Days.	
		Born.	Born alive.	Weaned.	*(1).	†(2).	Total.	Per Pig.	Total.	Per Pig.
					Per Cent.	Per Cent.				
March, 1933 ..	117	9·6	9·2	8·1	16·1	12·5	102	12·7	308	38·2
March, 1934 ..	118	9·2	8·6	7·7	15·8	10·0	97	12·2	290	37·5
March, 1935 ..	200	9·9	8·8	7·8	20·8	10·6	102	13·0	289	37·0
All records ..	435	9·6	8·8	7·9	18·3	11·0	100	12·7	295	37·5

*(1) Mortality-rate based on total pigs born. †(2) Mortality-rate on pigs born alive *i.e.* excluding still-born pigs.

In Table 1 the average results from all litters recorded are shown for each year, together with a summary for the whole three-year period.

By 31st March, 1935, the records of 435 sows were completed. These yielded the very good litter average of approximately 8 pigs weaned, 100 lb. per litter at twenty-one days, and 295 lb. at fifty-six days, while the average weight per pig at fifty-six days was 37·5 lb.

Since such figures provide a measure of the prolificacy and milking-capacity of the breeding-stock, the rate of maturity of the progeny, and the efficiency of feeding and management of the farmer, it is extremely satisfactory to note that in these respects the standard of pig-production in the Manawatu district amongst recording farmers compares very favourably with that of the Waikato and Canterbury areas, where litter-testing has also been carried out. It is also worthy of note that the results show an improvement over the results obtained in the Manawatu district in 1928, when 121 litters produced an average of 7·3 pigs weaned, 80 lb. per litter at twenty-one days, and 229 lb. at fifty-six days, with an average weight per pig of 31·5 lb.(2)

Yearly Variation.

Little significant difference occurs in the yearly averages; what difference there is shows a falling-off rather than an improvement in efficiency. Though this result on the surface is disappointing, it may be attributed safely to the following facts: (*a*) During the first year the 117 litters recorded included sixty-six litters from one herd in which the standard of stock and management was extremely high—the results contributed largely to the high averages of that year. Corresponding litters from this herd have not since been recorded owing to limitations of the club's finance. (*b*) The first year's operations covered mainly established pig herds; those of the latter years, largely newly formed herds. This is borne out by the fact that during the first year

the records included only 20 per cent. of maiden litters, while during the last two seasons 61 per cent. of the litters recorded were from maiden sows. (*c*) Since the litter averages of maiden sows tends to be lower than those of older breeding-stock, the increased number of the former is alone sufficient to account for the slight reduction in results. (See Table 8.)

Variation between Individual Litters and Herds.

While the average results indicate a satisfactory standard of general efficiency, examination of individual litter results indicates that extremely wide differences occur, and emphasizes the importance of litter-recording work in indicating to farmers just where and how their methods of pig-production are succeeding or failing and in locating profitable and eliminating unprofitable individuals and strains of breeding-stock.

Table 2.—Maximum Range of Differences in Litter Records.

—	Highest.	Lowest.
	lb.	lb.
Total litter-weight at twenty-one days	175	24
Average weight per pig at twenty-one days	21	6
Total litter-weight at fifty-six days	544	77
Average weight per pig at fifty-six days	56	15

While Table 2 emphasizes the tremendous range of differences existing between individual litters, a more effective picture of the extent and nature of such differences is shown by Tables 3 and 4, in which the litters are grouped according to the weight of the litter at fifty-six days. The litters dealt with in Table 3 showed the following broad distribution: (1) over 400 lb., 9·5 per cent.; (2) over 350 lb., 26·5 per cent.; (3) over 300 lb., 48·4 per cent.; (4) over 250 lb., 70·0 per cent.; (5) over 200 lb., 85·9 per cent.

Table 3.—Litter-production: Total Litter-weight.

Group Class.	Number of Litters.	*Average Number born.	Average Number weaned.	Average Litter-weights in Pounds at			
				Twenty-one Days.		Fifty-six Days.	
				Total.	Per Pig.	Total.	Per Pig.
Lb.							
100–150 ..	16	7·1	4·3	44·3	10·3	120	27·8
150–200 ..	42	8·0	5·8	62·1	10·7	178	30·7
200–250 ..	65	9·2	6·8	75·5	11·2	226	33·4
250–300 ..	90	9·1	7·5	88·2	11·7	280	37·2
300–350 ..	90	9·9	8·6	105·0	12·2	330	38·3
350–400 ..	70	10·9	9·4	120·3	12·9	369	39·4
400–450 ..	27	11·1	10·1	125·8	12·5	422	41·9
450–500 ..	7	12·6	11·9	131·0	11·5	465	40·7
500–550 ..	5	11·8	11·0	143·0	13·0	525	47·7

* Born alive.

Note.—The increase in total litter-weight is brought about mainly by an increase in the numbers weaned per litter, but not entirely, since the individual weight of the pigs is greater in the heavier litters both at twenty-one days and at fifty-six days.

Table 4.—Comparison of Litters above and below 300 lb. at Fifty-six Days.

Group.	Number of Litters.	*Average Number born.	Average Number weaned.	Average Litter-weights in Pounds at			
				Twenty-one Days.		Fifty-six Days.	
				Total.	Per Pig.	Total.	Per Pig.
Below 300 lb...	212	8·8	6·7	80	11·2	236	35·1
Above 300 lb.	199	10·6	9·3	115	12·3	368	39·7

* Born alive.

The Importance of Heavy Litters.

For economic reasons the *total litter-weight at fifty-six days* is perhaps the most important measure of efficiency of a breeding-sow. The sow which can produce regularly the greatest weight of pig-flesh at weaning-time, providing the pigs are of the right market quality, is the most profitable sow to the producer, whose aim therefore should be the attainment of good results in this respect. Heavy litters being associated with heavy individual pigs not only are important in themselves, but have a definite relationship with the subsequent rate of growth of the animals, heavier weaners retaining their more rapid rate of growth right through to the market stage.

Tables 3 and 4 illustrate the wide differences existing in total weaning-weights, a considerable number of litters ranging from 150 lb. to 450 lb. at eight weeks. Since the records have been obtained over a wide range of farms and breeding-stock, fed and managed under practical farming conditions, the results show that a *standard of 300 lb. per litter* at fifty-six days is a reasonable expectation from a breeding-sow. Approximately 50 per cent. of the sows tested attained this production.

If such a standard can be accepted, it provides a useful measure of efficiency which farmers may well employ in their pig-keeping operations, just as they now employ a similar standard in their cow-keeping practices, *i.e.*,—

A good cow produces 300 lb. butterfat per annum :
A good sow produces 300 lb. pig-flesh per litter.

The differences between individual sows and litters are similarly apparent between different herds. Thus Table 5 compares the " best " herd with the " worst " herd under test.

Table 5.—Comparison of Best and Worst Herd.

——	Number of Litters.	*Average Number born.	Average Number weaned.	Mortality.	Litter-weight at Fifty-six Days.
				Per Cent.	
Herd A ..	47	8·3	7·7	10	330 lb. : Average 43 lb.
Herd B ..	20	8·8	6·0	27	200 lb. : Average 34 lb.

* Born alive.

Though the " worst " herd had more pigs born per litter, a mortality rate of 27 per cent. considerably reduced the number weaned. This, combined with a lower weight per pig, gave the " best " herd a 65-per-cent. superiority in total litter-weight and a 26-per-cent. superiority in weight per pig, despite the fact that the figures cover more than twice the number of pigs in the latter herd.

It might be noted that herd A has been recorded each year and is one in which selection and culling, feeding and management methods have been guided largely by recording results. (In Table 13 there is given an example of sow A, which was taken from this herd.) The herd thus provides an excellent example, and by no means an isolated one, of the importance of continuous testing in the attainment of a high standard. Testing but one year cannot provide a sound basis for pig-improvement any more than testing dairy stock for one season can produce much effect upon the standard of dairy production.

Relative Importance of Number and Weight of Pigs upon Litter-weights.

Since the total weight of a litter is dependent upon the number of pigs weaned and the individual weight of the pigs at weaning-time, the pig-raiser, to secure heavy litters, must aim at both (*a*) large litters, and (*b*) heavy weaners.

Examination of Tables 3 and 4 gives additional weight to this point, the heavier litters being secured by a combination of both large numbers weaned and heavy pigs.

Furthermore, Tables 3 and 4, together with Table 6 below, show that (*a*) the number of pigs weaned is more important in securing heavy litters than is a heavy weight per pigling ; both, however, are necessary: (*b*) that the individual weight of the weaner is not dependent upon the number of pigs in the litter.

Table 6.—Litter-production : Number of Pigs weaned.

Number weaned.	Number of Litters.	Number born alive.	Average Litter-weights in Pounds at				Range of Average Litter-weight per Pig.	
			Twenty-one Days.		Fifty-six Days.			
			Total.	Per Pig.	Total.	Per Pig.	Maximum.	Minimum.
							lb.	lb.
3 ..	6	7·6	39	13·1	164	36·3	46	26
4 ..	13	6·0	51	12·7	172	43·0	51	29
5 ..	28	7·5	62	12·5	197	39·5	50	28
6 ..	48	8·5	73	12·2	234	39·1	54	27
7 ..	73	8·4	87	12·4	264	37·7	56	15
8 ..	79	9·7	98	12·2	298	37·1	56	21
9 ..	88	10·4	106	11·8	339	37·8	50	21
10 ..	56	11·3	119	11·9	380	38·0	53	23
11 ..	13	11·8	125	11·4	394	35·8	50	29
12 ..	8	12·3	128	10·7	459	38·2	45	25

Note.—The average weight of pigs in litters of ten is not materially less than the weight of the individual pigs in litters of five—that is, it is possible to obtain pigs averaging 50 lb. at eight weeks in litters of ten and eleven as well as in litters of five and six.

The Extent, Nature, and Importance of Mortality.

Apart from the fundamental and hereditary quality of prolificacy, which primarily determines the number of pigs born, the mortality-rate within a litter is the governing factor affecting the number of pigs weaned. All the foregoing tables emphasize the importance of the mortality-rate in this respect. Examination of the records in detail in respect to the nature and extent of the mortality is therefore of considerable interest, especially since many deaths in young pigs could be eliminated by efficient management.

Table 7.—Mortality Details.

—	1933.	1934.	1935.	Total.
Total number born ..	..	1,084	1,980	4,190
Still-born	(No data)	69= 6·4%	227=11·4%	402= 9·6%
Total number born alive	1,079	1,015	1,753	3,847
Number of runts ..	35= 3·2%	23= 2·3%	22= 1·3%	80= 2·1%
Number overlain and/or died	110=10·2%	79= 7·8%	164= 9·4%	353= 9·2%
Number weaned ..	934=87·0%	913=90·0%	1,567=89·4%	3,424=89·0%

It is necessary in examining mortality figures to distinguish between the total number of pigs born and the total number born alive. Still-born pigs are a common occurrence in pig-breeding, and are considered to be due partly to heredity and partly to nutritional defects or deficiencies. By avoiding strains showing this tendency and by paying due attention to the feeding of the sow at all times it is possible to reduce such losses to a minimum.

It is apparent from Table 7, however, that still-born pigs are of considerable importance, an average of nearly 10 per cent. being certainly a limiting factor to high weaning averages. In one herd in particular the average for some twenty-four litters was 20 per cent., a figure which reduced the number weaned to an average of seven pigs, although over nine per litter were actually born.

In respect to pigs born alive, approximately 2 per cent. were classified as "runts," and are not included in the weaning results. Of the remainder, approximately 9 per cent. were either overlain or died before weaning. Of this number, the majority were overlain, only 2·6 per cent. of the total number born alive dying from other causes.

Taking runts, deaths from overlying, and other causes into account, the total mortality in pigs born alive was 11 per cent. for the whole period. This figure, considering the large number of litters involved, must be considered fairly satisfactory, but it must also be emphasized that many deaths from overlying and other causes, and even many supposed cases of still-born pigs, can be eliminated by efficient management. The experience and observation of the recording officer has shown that better attention at farrowing-time, the provision of more effective housing and shelter, and better all-round management and feeding could result in the saving of many pigs. Individual herds still have mortality figures

of 30 per cent. and over, while, on the other hand, two herds, both handling more sows than the average farmer, have reduced the rate to 5 per cent. by increased attention to such matters.

The Effect of Age of Sow upon Efficient Production.

Table 8 sets out the average results according to the number of the litter—*i.e.*, age of sow. Although it might be assumed from the frequency figures that the average life of a sow is only four to five litters, this is not justified, since, as stated above, the larger number of herds are but newly established, and the majority of sows relatively young. Even the older herds have increased their numbers of recent years with a similar result.

Table 8.—Litter-production : Number of Litter.

(Age of Sow.)

Number of Litter.	Number of Cases.	Average Number born.	Average Number born alive.	Average Number weaned.	*Mortality.	Average Litter-weights in Pounds at		
						Twenty-one Days.	Fifty-six Days.	
						Per Pig.	Total.	Per Pig.
					Per Cent.			
First ..	83	8·7	8·0	7·2	9·8	11·2	266	36·9
Second ..	54	9·4	8·7	8·1	8·8	11·8	302	37·4
Third ..	65	9·9	9·2	8·0	13·7	12·6	307	38·5
Fourth ..	57	10·0	9·3	8·2	11·7	12·5	319	38·7
Fifth ..	24	10·2	8·9	8·4	6·1	12·5	317	37·8
Sixth ..	15	9·9	9·5	8·3	12·0	12·7	315	37·9
Seventh ..	6	10·8	9·3	8·0	14·3	11·9	341	42·7
Eighth ..	..	..	..	..	..	..	..	..
Ninth ..	2	11·0	9·5	6·5	31·6	11·4	235	36·3
Tenth ..	1	11·0	9·0	9·0	..	11·0	339	37·6

* Based on pigs born alive.

The above figures can be considered useful only up to the sixth litter, the number of cases after the sixth being too few for comparative purposes.

Maiden sows weaned fewer pigs and produced a lower total litter-weight than sows carrying their second to their sixth litter. This is in line with similar observations overseas(3). No significant difference is apparent between second, third, fourth, fifth, and sixth litters in respect to weaning-weights. The number of pigs born seems to increase with age, though there is little difference in number weaned except as noted in the case of maiden sows. The few sows recorded in their tenth and eleventh litters indicate that it is possible for a sow to retain her breeding qualities to this stage.

Effect of Season of Farrow upon Efficient Production.

Due to the seasonal nature of our supply of pig-foods, the month of farrow is frequently stated to be an important factor not only from the point of view of ease of management and avoidance of mortality, but also in respect to the securing of heavy litters. Many farmers claim that best results are obtained when the seasonal supply of milk is ample. Partly to investigate the truth of this contention, and partly because of the possible necessity of modifying the present management methods in respect to farrowing

dates due to the increasing importance of the baconer rather than the porker trade, the records have been grouped according to the month of farrowing. Tables 9 and 10 illustrate the position.

Table 9.—Litter-production: Season of Farrow.

(All records three-monthly periods.)

Season of Farrow.	Number of Litters.	Average Number born alive.	Average Number weaned.	*Mortality.	Average Litter-weights in Pounds at		
					Twenty-one Days.	Fifty-six Days.	
					Per Pig.	Total.	Per Pig.
				Per Cent.			
June–August ..	130	8·8	8·0	8·8	11·5	290	36·0
September–November	87	9·0	8·1	10·6	11·8	312	38·4
December–February ..	126	8·9	7·8	12·1	12·2	309	39·4
March–May	57	8·5	7·5	11·6	12·5	270	36·0

Table 10.—Mortality Details: Season of Farrow.

Season of Farrow.	Still-born.	*Runts.	*Overlain or died.	*Weaned.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
June–August	9·0	2·4	7·8	89·8
September–November ..	5·0	1·6	9·4	89·0
December–February ..	6·7	1·4	9·7	88·9
March–May	12·5	2·4	8·5	89·1

* Mortality on a basis of pigs born alive.

Table 9 shows that there is little material difference between the different seasons in respect to either number weaned or total litter-weight, or average weaner weights. The autumn period, March to May, and the winter-early-spring period—June to August—however, show to a slight disadvantage. There appears to be a difference from year to year in this respect, the records showing that in the March to May period in 1933 the litter average was 303 lb., while in 1934 it fell to 240 lb. Similarly, the winter-early-spring period in 1934 gave an average of 301 lb. per litter.

Table 10 similarly shows little difference in mortality figures on a basis of pigs born alive. The percentage of still-born pigs, however, is greater in the autumn period and the winter-early-spring period than during the summer. This figure of a higher percentage of still-born pigs during March to May is interesting, and merits further investigation.

In connection with month of farrow, the following table shows the distribution of farrowings of recorded litters throughout the year.

Table 11.—Monthly Distribution of Farrowings.

Month.	Farrowings.	Month.	Farrowings.
	Per Cent.		Per Cent.
January	11·6	July	16·2
February	8·1	August	13·4
March	6·4	September	10·0
April	4·6	October	3·4
May	6·0	November	3·4
June	9·3	December	7·6

Farrowings are apparently fairly well spread throughout the year. At the same time, they show a close relationship to the seasonal milk-supply, and indicate that farmers are making an endeavour to arrange their breeding operations so as to have pigs available to consume the seasonal flush of feed during late spring and early summer. Thus the most favoured period is June to September and the corresponding months December to March. July and January seem the most popular months.

It would appear, however, that, from the point of view of efficiency of production to the weaner stage, there is little objection to advancing the breeding operations to a still earlier date in the winter and summer; such a policy would have definite advantages should it become necessary, as it appears from present market trends, to concentrate more along lines of baconer-production than porker.

The Influence of Breed and Strain upon Efficiency of Production.

A comparison of the different breeds and crosses has further illustrated the fact that there are no significant differences between the different breeds of pigs so far as efficiency of litter-production is concerned. The four pure breeds (see Table 12) gave similar results both in total litter-weight and average weight per pig. Slightly more pigs were born in the Large Black and Large White breeds, but this was compensated for by a higher death-rate.

Table 12.—Litter-production: Breed or Cross.

Breed.	Number of Litters.	Average Number born.	Average Number weaned.	*Mortality.	Average Litter-weight in Pounds at			
					Twenty-one Days.		Fifty-six Days.	
					Total.	Per Pig.	Total.	Per Pig.
PURE-BRED LITTERS.								
				Per Cent.				
Tamworth ..	79	9·6	7·9	16·8	95	11·8	313	39·2
Large White ..	54	10·7	8·0	26·2	92	11·5	290	36·1
Large Black ..	34	9·9	7·1	27·9	85	11·9	287	40·2
Berkshire ..	35	9·5	8·1	15·6	94	11·7	292	36·3
	202	9·9	7·9	21·2	92·5	11·8	300	38·0
FIRST-CROSS LITTERS.								
Tamworth × Berkshire	42	9·2	8·2	11·1	93	11·4	286	34·8
Tamworth × Large White	7	11·6	9·0	22·3	111	12·3	358	39·9
Tamworth × Large Black	11	8·4	7·3	12·1	95	12·6	308	42·3
Berkshire × Large Black	5	8·2	7·4	9·8	92	11·5	284	38·3
	65	9·5	8·3	12·8	98	11·8	306	36·8
PURE-BRED SIRE × GRADE SOW.								
Tamworth Sire ..	104	9·1	7·6	16·4	92	12·1	276	36·2
Large White sire..	7	11·1	9·3	16·7	103	11·1	315	33·9
Large Black sire..	13	10·4	9·0	13·4	113	12·6	340	37·7
Berkshire sire ..	21	9·0	8·1	9·0	101	13·0	320	39·8

* Mortality based on total pigs born alive or dead.

The pure breeds compared very favourably with the first-cross litters and the grade litters by the pure-bred boar. The figures do not, therefore, support the contention often made that it is necessary to go to the first cross to obtain prolificacy, thriftyness, and rapid rate of growth. There were also no wide differences within the first cross or the grade litters.

These figures should serve to emphasize the far greater importance of strain within the breed rather than of breed itself. It is apparent from the information presented in the foregoing tables that there exist far greater differences between different individuals within a breed. It is well recognized that such individual differences are carried to strains, some strains being more productive than others.

The data of the Recording Club, while providing a basis for the location of such "good strains," are still insufficient for a detailed strain analysis. Although many different strains are under test, the influence of the management factor is so great as to make the interpretation of strain differences upon but a limited amount of material extremely difficult.

The following example, however, provides a good illustration not only of a highly productive strain of a certain breed in the same herd, and therefore under the one management, but also of the ability of a sow to transmit high-producing qualities to her progeny.

Table 13.—Records of Sow A and Progeny.

—	Number of Litters.	Average Number born.	Average Number weaned.	Weight in Pounds at Fifty-six Days.	
				Total.	Average.
Sow A	*4	8	7·0	316	44
Daughter B	†4	10	9·5	443	47
Average of four granddaughters *ex* sow B	‡4	11	9·5	380	40

* Tenth, eleventh, twelfth, and thirteenth litters. † First, second, third, and fourth litters.
‡ All maiden litters.

These pigs are from a strain twenty-two litters of which in the same herd produced an average of 8·2 pigs weaned, 375 lb. per litter at fifty-six days, and an average of 42 lb. per pig. Where pigs of similar breeding have come under test in other herds they produce consistently good results with reasonable management.

Litter Variation and the Effect of Size of Litter and Weaning-weight.

The production of good even litters which can be fed together and which are ready for market at the same age is of material economic importance. It is well recognized, however, that the individual piglets of a litter vary widely in weaning-weight—that they grow at different rates. Such differences are often primarily responsible for the marked lack of uniformity in the market weights of many lines of farmers' pigs reaching the slaughterhouse. This is especially so since few producers use the scales to determine the suitability of the weight of a pig for marketing, but rather market as "lines" the complete or nearly complete litter when the average reaches the approximate weight required.

It is therefore important to measure the extent of the variation in the individual weaning-weights of a litter. Such "litter variation" figures can be expressed on a percentage basis by the method employed by the East Anglia Pig-recording Scheme(3). In the litters under review considerable differences are apparent, the litter variation showing an extreme range of from 3 per cent. to 30 per cent., while the commonest variation occurred between 8 per cent. and 12 per cent.

To ascertain whether any connection exists between litter variation and the number of pigs in the litter, the variations have been grouped according to the number of pigs weaned. It will be seen from Table 14, however, that there appears to be no significant relationship. This result is in line with English experience(3).

Table 14.—Litter Variation and Number of Pigs weaned.

Number weaned ..	4	5	6	7	8	9	10	11	12
Number of litters ..	11	21	40	61	66	75	47	11	7
Average variation per litter (percentage)	11·8	9·6	14·4	10·0	11·1	9·9	13·0	8·6	9·4

On the other hand, comparison between the average weaning-weight and the litter-variation figures, as shown in Table 15, indicates that less variation exists in litters with a high average weaning-weight. Thus litters averaging less than 40 lb. per pig at fifty-six days show a litter-variation figure greater than 12 per cent., while litters averaging more than 40 lb. at weaning show an average litter variation of less than 9 per cent.

Table 15.—Litter Variation and Weaning-weight.

Average weaning-weight in pounds	25	27½	30	32½	35	37½	40	42½	45	47½
Number of litters ..	9	19	27	36	47	67	50	38	27	16
Average variation per litter (percentage)	13·4	14·2	13·1	12·8	12·0	9·8	8·9	8·0	8·5	7·8

It would appear that the adoption of methods which will ensure heavy individual pigs at weaning has an additional advantage in that such litters will tend to be more uniform in individual weights.

Influence of Management on Efficient Production.

In the first report of the club the influence of feeding and management upon the efficiency of litter-production was emphasized. While the results obtained from litter-testing measure to some extent the prolificacy, the milking-capacity, and the capacity for motherhood of the breeding-stock, they also reflect very largely the feeding and management methods of the farmer.

The pig-recording work up to the present time suggests that the greatest limiting factor to efficient weaner-production is not the quality of the breeding-stock, but the quality of the management, and that the

large majority of farmers could effect marked and immediate improvement in their results from pig-breeding by a closer attention to their husbandry. At the present time it is clear from the fact that less than 50 per cent. of the litters even of recording farmers reach the standard suggested as practicable that there is a large and unprofitable "tail" to the industry.

For this reason the greatest value of litter-recording work lies in the light it throws upon just how and where the management of individual farmers is succeeding or failing. Good animals in themselves are not sufficient; they must be accompanied with good management if they are to express their inherent productive qualities. By continuous testing of performance, and by the application of the lessons provided, recording can be of material aid in the attainment of consistent and efficient results.

The major management factors which play a part in heavy litter-production are briefly—(1) Good feeding of sow and litter at all times; (2) the provision of the creep for the litter from three weeks onwards; (3) the rational use of concentrates for both sow and litter to supplement dairy by-products; (4) the provision of warm draught-proof houses; (5) provision of shelter; (6) access to clean short leafy pasture; (7) care and attention at farrowing; (8) care, regularity, and cleanliness in feeding.

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VACCINATION OF EWES AGAINST PULPY KIDNEY (INFECTIOUS ENTEROTOXAEMIA) IN LAMBS.

TRIALS IN CENTRAL OTAGO, SEASON 1935.

C. V. DAVUS, District Superintendent, Department of Agriculture, Dunedin.

IN the March, 1936, issue of the *N.Z. Journal of Agriculture* there appeared an article by Mr. Dudley A. Gill, M.R.C.V.S., D.V.S.M. —a summary of his paper entitled "Infectious Enterotoxæmia and the *Clostridium welchii* Group, with Special Reference to So-called Pulpy Kidney in Lambs," which was read at the 1935 Science Congress of the Royal Society of New Zealand.

In the original paper the author made a strong suggestion that trials should be made of a possible method of protecting lambs against pulpy kidney by the vaccination of the ewe with a formalinized enterotoxæmia (*Clostridium welchii*, type D) vaccine. Behind this was the idea of the transference of a passive immunity to the lamb through the medium of the ewe's colostrum, with the hope that any such immunity would be sufficiently lasting through the most important susceptible period—*i.e.*, between the third and fourth week of the lamb's life. Dalling and his colleagues, working in England on lamb dysentery, had demonstrated the presence of an antitoxin in the colostrum of ewes, following vaccination during

pregnancy with a vaccine prepared from the lamb dysentery organism (*Clostridium welchii*, type B). This antitoxin could also be detected in the blood of the lamb shortly after it had first suckled a vaccinated mother. By this method a high degree of protection was given to lambs from lamb dysentery, which previously caused heavy mortality in the first few days of life. Trials were undertaken in Central Otago during the 1935 season, in which pregnant ewes were vaccinated with a formalinized enterotoxæmia vaccine, and it is the purpose of this article to record the results obtained.

Vaccination Trials.

At the outset it was intended to vaccinate approximately 1,000 ewes and hold a corresponding number of controls on farms where the disease in lambs had been known to exist in former seasons. The vaccinated ewes were to depasture together under identical conditions.

It was proposed to give the ewes two doses of vaccine, the first dose approximately six weeks before lambing and second dose a week or ten days before lambing. However, owing to the vaccine not being available in time, this intention could not be followed strictly, and the above intervals had necessarily to be shortened. In September, 1935, the first dose of vaccine was given to 1,370 ewes. The particulars are shown in Table I.

Table I.

Farm.	Ewes vaccinated.	Controls.	Date of First Vaccination.	Dose.
A	150	150	4/9/35	5 c.c.
B	530	530	5/9/35	5 c.c.
C	212	212	6/9/35	5 c.c.
D	190	150	6/9/35	5 c.c.
E	288	310	7/9/35	5 c.c.
Total ..	1,370	1,352	..	..

For the purposes of vaccination, on each occasion the ewes were run into a race, packed fairly firmly, but not crushed in any way. The wool was parted just behind the shoulder blade and the site of injection swabbed with methylated spirits. The skin in the area was then raised and the needle of the hypodermic syringe inserted and the requisite dose given subcutaneously. Afterwards the vaccinated ewe was marked on the head with paint.

Just under three weeks after the first, the second vaccination was done. The particulars are shown in Table II.

Table II.

Farm.	Ewes vaccinated.	Controls.	Date of Second Vaccination.	Dose.
A	..	..	..	..
B	527	530	24/9/35	10 c.c.
C	198	212	25/9/35	10 c.c.
D	190	150	23/9/35	10 c.c.
E	285	310	25/9/35	10 c.c.
Totals ..	1,190	1,202	..	..

The second vaccination was not carried out on Farm A, as the ewes had commenced to lamb by this time, and under the circumstances the owner did not feel inclined to yard and draft for vaccination.

Subsequently the work consisted of keeping observations on the vaccinated ewes and controls and checking up the lamb mortality. A few colostrum samples and blood samples from lambs were collected and sent to the Veterinary Laboratory at Wallaceville for testing as to the presence of antitoxin. By the middle of December the losses of lambs which could be attributed to pulpy kidney had ceased. The relation of deaths of lambs in the vaccinated-ewe group as against those in the control group are shown in Table III.

Table III.

Farm.	Vaccinated Ewes.	Lamb Deaths from Pulpy Kidney.	Control Ewes.	Lamb Deaths from Pulpy Kidney.
B	527	1	530	24
C*	198	..	212	..
D†	190	Nil	150	8
E	285	1‡	310	35

* Six or seven lambs were lost in this lot, but, owing to the ewes leaving the dead lambs, it was not possible to identify the lambs with either vaccinated or control ewes, except in one case where a lamb from a control ewe was definitely identified.

† On this farm it must be mentioned that the control ewes were not running with the vaccinated ewes, but were under similar conditions in an adjoining paddock.

‡ This lamb died the morning after docking, and there is some doubt as to whether the actual cause of death was pulpy kidney.

If both farms C and D are excluded, and the lamb which died among the vaccinated group on farm E is counted as a definite case of pulpy kidney, we have the following result :—

812 vaccinated ewes—Pulpy kidney losses among lambs, 2 = 0·24 per cent.

840 control ewes—Pulpy kidney losses among lambs, 59 = 7·02 per cent.

Discussion.

The above figures give rather striking results, and there is no doubt that the field evidence in the 1935 season fully justifies the trials and gives most encouraging support to the possibility of successful vaccination of the ewes with a vaccine prepared from *Clostridium welchii*, type D. It certainly appears that a considerable degree of immunity is conferred on the lamb through the colostrum of the mother, and a further extension of this experimental work is warranted next season, on an extended scale if possible.

The farmers chiefly concerned are enthusiastic regarding the success of vaccination, and are prepared to have further trials carried out.

The laboratory examination of the colostrum and blood of lambs from vaccinated ewes would indicate the presence of antitoxin. Owing to various circumstances this work was not carried to its ultimate conclusion, but as far as it went the results obtained were definite, and

suggest strongly that some protection was afforded. Dr. Hopkirk, Officer in Charge, Veterinary Laboratory, furnishes the following report :—

"Tests against mice were made as follows :—

"(1) Five colostrum samples from vaccinated ewes : Mice protected by 0·015 c.c. of whey in three cases, and by 0·02 c.c. in two cases. The three lambs' sera from these ewes have not been tested.

"(2) Ten lambs' sera from vaccinated ewes : Mice protected by 0·015 c.c. in six cases ; by 0·02 c.c. in one case ; by 0·025 c.c. in one case, by 0·1 c.c. in one case, and not protected by 0·5 c.c. in one case. Colostrum from the dams of these lambs not taken.

"(3) 0·015 c.c. whey from ewe's colostrum taken before birth protected mice ; milk after birth not taken ; 0·02 c.c. serum from lamb out of this ewe protected mice.

"There were no samples of normal unvaccinated lambs' or ewes' sera sent up for control tests, but two normal ewes' bloods here gave no protection whatever against the toxin."

Conclusion.

A method of protecting lambs from deaths due to pulpy kidney which has given encouraging results is indicated. It is practical and economical in application.

Certain acknowledgments are due in connection with this work to D. A. Gill, M.R.C.V.S., D.V.S.M., for the suggestion that the trials be carried out ; to Dr. Hopkirk for the preparation of the vaccine and tests for antitoxin ; to A. L. Thompson, M.R.C.V.S., for carrying out the vaccination work ; to J. Fleming, Inspector of Stock, Ranfurly, for field arrangements ; and finally to those farmers in Central Otago who willingly co-operated with us.

CARE NECESSARY IN USE OF WORM-DRENCH FOR SHEEP.

PRECAUTIONS TO BE TAKEN IN PREPARING COPPER SULPHATE (BLUESTONE) AND NICOTINE SULPHATE DRENCH.

E. E. Elphick, Veterinarian, Hastings.

In spite of the long period over which copper sulphate has been used for the drenching of sheep and lambs, there still appears to be a great deal of misunderstanding about the size of the dose, and often an almost criminal carelessness in the weighing of the material and the measurement of the water. Cases of its improper use, particularly with regard to miscalculation of the dose, have frequently come to notice. Few farmers freely admit doing something wrong, but the misfortunes resulting from the misuse of a particular treatment soon become known and tend to bring discredit upon a drug which, if used properly, has only beneficial effects.

There is nothing to be gained by starving prior to drenching. In fact, the chances of an accident are much reduced if the animals are

drenched as soon as possible after being brought into the yards. For many years it has been the custom for farmers to hold their sheep and lambs off feed for twelve hours or so before drenching, but recent experiments have shown conclusively that results are quite as good if this preliminary period of starvation is omitted altogether. The sheep may be brought in and drenched as soon as they have settled down, and not only is this much more convenient for the farmer but also is far less of a strain on the sheep.

As a routine practice, lambs should be first dosed at weaning and dosed at least monthly thereafter. In seasons such as the present one, when worm-infestation is likely to be especially troublesome, dosing at intervals of about sixteen days is desirable. Apart from its use as a destroyer of parasites in the stomach and bowels, copper sulphate has a distinct tonic effect if given in proper doses.

The copper sulphate should be clean and bright, and should be mixed in a porcelain, enamel, or wooden vessel, and not used until thoroughly dissolved. Boiling water should be used in preference to cold when mixing.

One pound of copper sulphate to 5 gallons of water is the stock solution now recommended, with the addition of 16 fluid ounces of commercial 40-per-cent. nicotine sulphate. One half-ounce of this contains between 4 gr. and 5 gr. of copper sulphate, and is a sufficiently large dose for a lamb of from four to seven months old. For sheep of from eight to twelve months the dose may be increased up to 1 oz., depending upon the size and general health, and grown sheep should be given 1½ oz.

The mixture has a particularly astringent action upon the membranes about the throat, so care should be taken not to hurry the dosing, or some of the material may go into the breathing passages.

A mortality which occurred in recent months amongst lambs drenched with bluestone may be quoted in illustration of the necessity for accurate dosing. The lambs were held over-night and dosed during the following morning. The solution used contained 3 oz. to the gallon; and 1 oz. to 2 oz. of the material were given. These lambs were about five months old, and the amount of copper sulphate that each received was from 9 gr. to 18 gr. Some of the lambs were noticed to be ill within a few minutes, and died within two hours. The mortality was really quite a heavy one. A number recovered, but only after some weeks.

COMPARISON OF GROWTH IN SEXED AND IN UNSEXED PULLETS.

W. L. JOURDAIN, Government Poultry Station, Department of Agriculture, Wallaceville.

THE purpose of the trial recorded herein was to ascertain the difference in growth, if any, during the first six weeks between sexed pullets when reared separately and pullets when reared in the usual way (unsexed) with cockerels. The chickens used in this test were hatched on the 17th September, 1935, and 274 (unsexed) chickens were placed under

an electric brooder. They were weighed before being put under the brooder, and were thereafter weighed when seven, fourteen, and twenty-eight days old, and the pullets only on the forty-second day after being hatched. (See Table No. III.)

The chickens were fed on a dry-mash mixture, which was before them all the time. (Table I.) At 5 p.m. they were fed a little scratch grain, as shown in Table I, to encourage them to work, but it was noticed that they never at any time appeared ravenous for this grain. After the fourth day a mixture of young green oats and silver beet, finely cut up, was fed separately between meal-hours at 9 a.m., 2 p.m., and after the last meal at 5 p.m. Skim-milk and also water were given them to drink from the start. Fine oyster-shell grit was always before them in an open hopper—this allowed them to consume as much as they required.

Thus it will be seen that this lot was treated in exactly the same manner as the sexed pullets were treated in pen 2 of the trial which was described in the April issue of this *Journal*, wherein detailed information about the feed consumed by the sexed pullets is given.

The mash and grain mixture were made up as follows :—

Table I.

Mash.	Grain-mixture.
40 lb. ground maize (maize-meal).	75 lb. (3 parts broken wheat).
20 lb. bran.	25 lb. (1 part broken maize).
14 lb. pollard.	
10 lb. ground oats (not oat-meal).	

After the first week approximately 3 per cent. of meat-meal and 3 per cent. of bone-dust were included in the mash.

Table II gives details of the amount of food consumed, the cost of the food, and also the total of food consumed for six weeks ; but as some of the cockerels were taken out of the pen after twenty-eight days and some were kept for further use it is not possible to compute the average cost of rearing the 126 pullets for six weeks. As mentioned at the outset, the object of the test was to see if any difference in the growth developed during the first six weeks between sexed and unsexed pullets.

Table II.

Foodstuff.	Price.	Amount consumed.		Cost.		
		lb.	oz.	£	s.	d.
Maize-meal	9s. per 100 lb.	226	0	1	0	4·08
Bran	7s. per 100 lb.	113	0	0	7	10·92
Pollard	6s. 6d. per 100 lb. ..	81	0	0	5	3·18
Ground oats ..	15s. per 100 lb.	50	0	0	7	6
Meat-meal	8s. per hundredweight ..	15	7	0	1	1·232
Bone-dust	12s. per hundredweight ..	14	12	0	1	6·964
Wheat	5s. 7d. per bushel (60 lb.)	42	0	0	3	10·9
Maize (kibbled) ..	5s. per bushel (50 lb.) ..	14	0	0	1	4·8
				£2	9	0·076

The following are the details of the number and weights of chickens, and also days of weighing :—

Number.	Age.	Weight.	Average Weight.
MIXED OR UNSEXED CHICKENS.			
	Days.	lb. oz.	oz.
274 chickens	1	25 3¼	1·47
269 ,, ...	7	33 11	2·01
263 ,, ...	14	52 14¼	3·22
261 ,, ...	28	117 7	7·14
126 pullets	42	81 13½	10·39
SEXED PULLETS.			
	Days.	lb. oz.	oz.
102 pullets	1	8 8	1·33
98 ,, ...	14	20 13	3·39
98 ,, ...	21	30 10¾	5·01
96 ,, ...	28	44 10¾	7·44
96 ,, ...	42	76 3	12·66

The above figures show that the one-day-old mixed chickens averaged 1·47 oz. as against 1·33 oz. for the sexed pullets, which would indicate that day-old cockerels are slightly heavier than day-old pullets.

At six weeks old the pullets which had been reared with cockerels only averaged 10·39 oz. as against 12·66 oz. for the sexed pullets, thus showing that the sexed pullets grew more rapidly when reared by themselves.

Both lots of chickens were from the same parent stock.

The 274 chickens had the use of one brooder, while the 102 sexed pullets had the use of one-half of a brooder of similar size and type.

FARMING IN THE AUCKLAND PROVINCE.

OBSERVATIONS ON FARM-MANAGEMENT METHODS.

P. W. SMALLFIELD, Fields Superintendent, Auckland.

V. THE CENTRAL PLATEAU AND THE WESTERN UPLAND.

THE Central Volcanic Plateau forms the main watershed of the North Island; commencing south of Lake Taupo, it stretches across the North Island from the main mountain-range on the east to the high elevated marine plain on the west, and extends northwards as far as the Bay of Plenty. Relatively flat over wide areas, the plateau rises here and there into high volcanic cones, flat-topped hills, and serrated ridges. Rhyolite lava-flows and large masses of pumicestone form the tableland, and the numerous volcanic cones that occur throughout its extent are built up of rhyolite, andesite, and partly also of basalt. Lake Taupo is everywhere surrounded with volcanic rocks which form a high tableland from 2,000 ft. to 2,200 ft. above the level of the sea and upon which numerous volcanic cones arise. The Waikato River leaves Lake Taupo at the north-east end and shapes its course north-east for a distance of about twenty miles, flowing through a broad terraced valley on the boundary of the Kaingaroa Plain. After its junction

with the Waiotapu River the Waikato makes a sharp turn to the west, flows through a mountainous region in a deep gorge, and emerges near Maungatautari in the broad plain of the Middle Waikato Basin. The Mokau rises on the flanks of the Hauhungaroa Range and flows to the west coast, entering the sea about half-way between Kawhia Harbour and New Plymouth. The Waipa has its source upon the Rangitoto Range and joins the Waikato at Ngaruawahia. The Wanganui River rises on the Central Plateau at the foot of Mount Tongariro, and the

FIG. 8. MAP SHOWING ROTORUA, TAUPO, TAUMARUNUI, WAITOMO, AND KAWHIA COUNTIES.

Rangitaiki River, which enters the sea between Whakatane and Matata, rises in the mountains to the east of Lake Taupo and flows along the edge of the Kaingaroa Plain.

The Western Upland is a continuation of the coastal ranges of South Auckland, and consists of a broad and deeply dissected plateau, based on beds of greywacke, conglomerates, limestones, and claystones, covered in parts and sometimes to considerable depths by an accumulation of rhyolite tuff and breccia, the product of eruptions in the Taupo district. In the west only the finest dust was deposited, and this has

formed the brown sandy-loam soil characteristic of large parts of the area. The Western Upland is divided from the Rangitoto and Hauhungaroa Ranges on the edge of the Central Plateau by a depression running north and south, which is about eight miles wide at Te Kuiti and widens in the south to eleven miles opposite Okahukura. The northern end of the depression is drained by the Waipa. The Mokau, after crossing the depression, flows in a southerly direction and five miles south of Pio Pio the river drops over the Wairere Falls and enters the Totoro Gorge, which is nine miles in length and 100 ft. to 200 ft. deep; several miles below the Wairere Falls the river receives the Mokauiti; the little Mokau, its principal tributary from the left. Three large branches of the Wanganui River drain the southern part of the district—the Ongarue, the Ohura, and the Tangarakau.

Generally the climate is mild and humid; the mean annual rainfall is about 50 in., but on the elevated areas of the west the rainfall increases to 80 in. to 100 in. On the Central Plateau the winters are cold, unseasonable frosts occur, and snow falls on the mountains in the winter.

Originally most of the country was heavily forested, but on the pumice plains of the Central Plateau occurred large areas of open tussock grassland, on which, since the invasion of rabbits and the occurrence of fires, the vegetation over large areas has changed to manuka and manoao scrub. The heavily forested areas of the Western Upland were settled early in the present century on the completion of the Main Trunk Railway. The bush was felled, burnt, and the land grassed; but settlement has not prospered on certain areas. The rainfall is heavy, many of the soils are composed of light volcanic ash and require phosphatic top-dressing, and a good deal of surface-sown grassland has deteriorated and reverted to second growth of fern and manuka. Blame for reversion has been attached to the type of grass mixture originally sown, which usually consisted of rye-grass, cocksfoot, and clovers; as soon as the initial high fertility derived from the ashes of the burn fell, white clover went out and was followed by rye-grass and cocksfoot, the carrying-capacity fell, and the bare ground was occupied by fern and manuka. The grass-mixture for a bush burn on this type of land should provide for a temporary high fertility in an extremely available form, a medley of soil types, a strong volunteer weed growth, and an ultimate reduction of fertility over all the area. A suitable mixture consists of perennial rye-grass, 12 lb.; Italian rye-grass, 4 lb.; cocksfoot, 8 lb.; crested dogstail, 3 lb.; *Poa pratensis*, 1 lb.; brown-top, 1½ lb.; *Danthonia pilosa*, 3 lb.; white clover, 2 lb.; *Lotus major*, 1 lb.(22). The Italian rye, perennial rye, and cocksfoot provide feed during the early years all over the burn, and the perennial rye, cocksfoot, and white clover remain where the fertility is kept high, whilst the danthonia and brown-top come in as fertility falls, make a complete turf, and help to prevent deterioration. The use of a sound seed-mixture is only the foundation in the battle against secondary growth; crushing with stock, clearing up logs, and resowing all have to be carried out if secondary growth is to be controlled. "No seed mixture, however, that could possibly be devised in itself will control secondary growth. The predisposition of this class of country under review to run to forest is too strong, and these secondary-growth associations must be recognized as stepping-stones back to

forest. Natural grassland associations are possible without man's assistance only where scrub land or forest land is impossible owing to climate. The act of felling and burning the forest does not alter one whit the urge of the country to afforest itself. It simply sets back the successional development, or converts what one may term a stable climax association into one of flux, with all the inherent vigour of youth and opportunities for development according to the habitat conditions meted out "(23).

Settlers were helped to some extent in checking deterioration by the Deteriorated Lands Act, 1925: "An Act to make Provision for the Relief of the Occupiers of certain Crown and other Lands in respect of Hardships due to Deterioration of such Lands or to their Natural Lack of Productivity." Revaluation committees were set up under the Act, with power to revalue the land and to recommend remission of rent or interest, consolidate and reclassify farms, and recommend advances and define the purposes for which advances should be made. Here are two reports of the revaluation committees:—

(1) "Farm of 1,129 acres, of which 1,100 acres of bush land have been felled and grassed and consist of 600 acres reverted to fern and 500 acres of poor pasture and 29 acres of standing bush; the farm carries 400 ewes, 200 dry sheep, and 70 cattle; the carrying-capacity could be increased a little with top-dressing and should show better returns, but unless it is top-dressed the carrying-capacity will decline still further."

(2) "Farm of 800 acres, of which 230 acres are in fair pasture, 328 acres second growth and fern, and 242 acres standing bush; carrying-capacity, 450 ewes and 20 cattle; a very poor section, and one on which an enormous amount of money has been lost; there are only 230 acres of the section worth farming, the balance is all poor hills with cliffs and bluffs; it is all running back to fern and second growth. Carrying-capacity on the whole will decrease and cannot be improved. If the 230 acres of the farm near the road could be kept clean and top-dressed it would carry stock for an indefinite period, but the remainder of the section is not worth trying to save."

Pasture deterioration consisted of two phases—first, the lowering of fertility and consequent deterioration of the pasture sward; and, secondly, the invasion of second growth—bracken fern, hard fern, water fern, manuka, and piripiri (hutiwai). Management methods to control deterioration consist of fencing and crushing with stock, logging-up, cutting manuka, resowing after manuka and bracken-fern burns, and top-dressing. To be effective, top-dressing requires the presence of clovers in the pasture—if clovers are absent or present only to a very limited extent, improvement by top-dressing is very slow. The first application to poor hill pastures slightly increases the clover content of the pastures, gives a somewhat better colour to the grass, and may improve the thriftiness of the live-stock; the second application leads to a further improvement in the clover content, consequent improvement in growth of grass, and improved carrying-capacity. For a start, top-dressing should be confined to the best grassland and used to assist in the establishment of secondary sowings on manuka and bracken-fern burns. Top-dressing must be carried out on a systematic plan and accompanied by an increase in stocking if the additional feed produced is to be made use of.

A good deal of improvement was effected by top-dressing, but most of this was lost during the depression years, when low wool and stock prices made the practice uneconomic. Secondary sowings following manuka burns for the establishment of danthonia, brown-top, and dogstail also proved satisfactory; but again the depression years held up improvement along these lines. At the present time some deteriorated Crown sections are being improved by the Small Farms Board; where the land is ploughable the areas are being cleared, ploughed, and resown for dairy-farming, and the new pastures sown down are to be maintained by top-dressing.

*Table VII.—Crops and Live-stock: Table showing Areas in Crops and Pasture and Numbers of Live-stock in the Central Plateau and Western Upland Counties, 1933–34 Season.**

County.	Crops.			Live-stock.			
	Annual Crops.	Pasture.	Pasture cut for Hay and Silage.	Dairy Cows.	Other Cattle.	Sheep Shorn.	Pigs.
	Acres.	Acres.	Acres.				
Kawhia ..	544	79,237	471	6,013	16,740	64,105	1,793
Waitomo ..	5,216	274,577	4,717	21,409	54,976	281,085	7,287
Rotorua ..	2,778	61,305	4,550	10,998	11,786	28,645	4,663
Taumarunui ..	1,675	99,527	1,747	5,793	15,754	117,067	2,261
Taupo ..	1,114	28,072	1,342	2,568	4,336	7,193	930
	11,327	542,718	12,827	46,781	103,592	498,095	16,934

* From Agricultural and Pastoral statistics.

Farming consists in grazing Romney sheep and beef cattle on the surface-sown hill country, and dairy-farming and fat-lamb raising on the undulating hills and flat land in river-valleys and on lake-shores. Much of the pumice country on the Central Plateau is naturally unhealthy for sheep and cattle; the complaint experienced is known as "bush sickness," and occurs chiefly on areas of wind-borne pumice ash, areas of water-borne pumice being generally free from the complaint. Bush sickness for many years hindered settlement of pumice land on the Central Plateau, but it is now satisfactorily treated with limonite licks for cattle and sheep(24).

TAUMARUNUI COUNTY.

May 13th, 1935: Lake Taupo, Tokaanu to Kuratau Stream.—"The name Taupo," remarked Hochstetter, "reminds me of one of the grandest natural sceneries I have ever seen." The great lake, the numerous volcanic cones, the snow-clad Kaimanawa Mountains, and the great open pumice plains, practically untouched by settlement, is a sight ever to be remembered. A fine sunny autumn day, and the launch trip across the edge of the lake, past Waahi and Pukawa Villages, to the Kuratau landing was very pleasant. The west shore of the lake is formed of vertical cliffs of rock, which, near Karangahape, reach a height of more than 1,000 ft. above the level of the lake, and landing is only possible in a few places. At the mouth of the Kuratau Stream Maoris were busy digging their potato crops. Here is cropping-land that has been used by the Natives for centuries; when exhausted with cropping, it is allowed to grow weeds until it recovers, and fresh

patches are taken for cropping. The soil consists of 12 in. of a dark, free-working sandy loam on a subsoil of weathered pumice silt. One could not help thinking what an improvement the use of good potato-seed, red clover, and superphosphate would bring about in the potato-culture. Up on the terraces of the river the soils are sandy and overlie a coarse, sandy subsoil containing a good deal of river shingle. Passed over the hills towards Mount Pukekikiori, and the level of the plateau is here 1,400 ft. to 1,600 ft., but on the return to Waahi the height is 1,900 ft. in places. Here on the western side of Lake Taupo is a great open tableland originally a great tussock plain, but now largely covered in manuka, fern, and manoao, with tussock only in the colder hollows. Up to a few years ago the Maoris ran sheep on this plain, but, with the rest of the tussock grazing-areas round Taupo, this has now been abandoned. On the south of the plain are bush-clad mountains (Kakaramea, 4,259 ft.), and away to the west the high bush-clad mountains of the Hauhungaroa Range, beyond which lies Taumarunui; to the north can be seen Mount Tauhara (3,603 ft.), where the Waikato leaves Lake Taupo, and in the distance the peak of Titiraupenga (3,383 ft.) and the wooded ridges of the Rangitoto Range. This great open pumice plain on the west of Lake Taupo contains a considerable area of potential farming-land, but at present there is no farming in the eastern part of Taumarunui County.

October 29th, 1935: Waimiha to Taumarunui.—The terraces of the Waimiha River are here about 800 ft. above sea-level, and at Waimiha there is a Native-land settlement block which has recently been developed. At this time of year the pastures look remarkably well, having a strong growth of white and red clover, cocksfoot, and rye-grass. Originally these pumice flats were in short manuka, manoao, and tussock: the land was ploughed and sown in permanent grass. Subsequent management has developed two types of pasture: where establishment, grazing, and top-dressing have been good, pastures of rye-grass, cocksfoot, and white clover have been established, whilst where the initial establishment was poor, or a red-clover smother occurred, the pastures consist of cocksfoot and red and white clover. It is only the first type of pasture that is profitable—a cocksfoot, red and white clover pasture throws no winter or early spring feed and is very difficult to manage. Further, this type of pasture is liable to degenerate to danthonia, sweet vernal, and suckling clover if close-grazed during the winter. The road and railway from Waimiha to Taumarunui follow the valley of the Ongarue River, which joins the Wanganui River at Taumarunui. The land consists of pumice terraces in the river-valleys, rising to steep manuka and fern-clad hills. Areas of the lower hill country were once grassed, but have now reverted to manuka. Originally the steep hillsides were clothed in strong bracken fern and tutu, and the initial establishment of a pasture was fairly easy. The fern was burnt and grass and clover seed sown in the ashes of the burn. Red clover established well, provided plenty of feed, and the fern was crushed out, but after the red clover disappeared from the pastures carrying-capacity declined, and fern and manuka came in. The soils of the pumice hills require regular top-dressing if good pastures are to be maintained. Many of the developed dairy-farms on the flats show a good deal of ragwort in the pastures, and sheep are really necessary on this country to control the weed. The chief pasture areas of Taumarunui County

consist of surface-sown bush land on which are grazed Romney sheep and beef cattle ; for the 1933–34 season there were 117,067 sheep shorn and 63,767 lambs tailed in the county.

TAUPO COUNTY.

May 9th, 1935 : Tokaanu.—Visited Hautu and Rangipo Prison Farms. All this country was once an open tussock plain, but rabbits and fires converted it into scrub lands. At Otukou Pa (Kaitieke County) near Lake Roto Aira there are still the wool-shed and sheep-yards remaining from the days when a considerable number of half-bred sheep were grazed over these plains. Prior to development, the flats at Hautu and Rangipo were in heavy manuka and the hills in fern and tutu. It is good healthy pumice country, and the river-flats contain a good deal of greywacke shingle brought down by streams from the Kaimanawa Mountains. Some of the grassing at the prison farms was done before supplies of certified perennial rye-grass seed were available, and pastures sown with short-lived strains of rye-grass show interesting features. Without perennial rye-grass these pumice hills cannot be satisfactorily grassed : short-lived strains of rye-grass go out and leave cocksfoot and white clover, which makes a fair pasture only if it is top-dressed and not heavily grazed in the winter. At Rangipo, where cattle-fattening is the main industry, these pastures have stood quite well, but at Hautu, where breeding ewes and cows are carried, some of these swards have deteriorated to danthonia. A cocksfoot - white-clover pasture will not stand hard winter grazing : rye-grass is absolutely necessary and rye-grass-white-clover-cocksfoot pastures can be maintained only if they are regularly top-dressed.

May 16th, 1935 : Tokaanu to Reporoa.—The eastern shore of Lake Taupo is flat, and is composed of great banks of pumicestone sloping down to a sand-beach, and beyond the pumice plains and hills extend back to the Kaimanawa Ranges ; at the north-east end of the lake the great Kaingaroa plains extend north-east as far as Murupara ; once a great plain of tussock-grass, the area is now almost completely planted in pine forests. Between Taupo and Rotorua there is a depression in the general level of the Central Plateau ; whilst the main level of the plateau is about 2,000 ft., much of the land in the depressed area—roughly the land lying between the two roads from Rotorua to Taupo—is from 1,000 ft. to 1,600 ft. in elevation, but right across the middle of the area lies the Paeroa Range, and numerous volcanic cones occur through its extent. The road from Wairakei to Reporoa crosses over great terraces of pumice sand, across the bend of the Waikato River, which first flows north-east on the margin of the Kaingaroa Plain and then turns west at its junction with the Waiotapu River. All this great stretch of pumice hills and terraces is now being planted in pine forests. Pioneer settlers were attracted to settle in the Waiotapu River Valley, near its junction with the Waikato River, by the existence of considerable areas of flax-swamps : from the swamps development spread to the open pumice plains. After the war, returned soldiers were settled on the Reporoa Estate, and, more recently, further land on Mr. Earle Vaile's Broadlands Estate has been developed for settlement under the small-farm plan.

(To be continued.)

THE DAIRY SUPPLIERS REGULATIONS, 1936.

By clause 55 of the Dairy-produce General Regulations, 1933, a supplier who during any manufacturing-season delivers his supply of milk or cream to a cheese-factory, creamery, or skimming-station must not transfer his supply during the same season to any other cheese-factory, creamery, or skimming-station unless he obtains the consent of the owner or manager of the manufacturing dairy to which his supply is being delivered. A supplier is at liberty, however, to transfer his supply without consent where the owner of the manufacturing dairy to which his supply is being delivered ceases to carry on the business of purchasing milk or cream or for any reason refuses to continue to purchase supplies from any particular supplier.

By the Dairy Suppliers Regulations, 1936, the right of a supplier to transfer his supply on the grounds mentioned shall not apply where during any manufacturing-season a purchase or merger of existing interests has been effected by owners of dairy factories with a view to the elimination of competition for supplies. In any such case suppliers to the factory of the vendor whose premises have been closed down must deliver their supplies to the purchaser for the remainder of the season. Where owners of dairy factories have agreed upon a voluntary zoning-system with a view to eliminating overlapping in the cartage of supplies, any supplier affected by the agreement must deliver his supply for the remainder of the season to such one of the owners, being parties to the agreement, as is nominated by notice served on the supplier.

—A. E. Morrison.

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CERTIFIED CROPS.

UNDER the Government scheme for the certification of seed-wheat, the following growers have seed from crops which have passed both field and grain inspections. (Previous lists, to which purchasers are also referred, were published in the March and April issues of the *Journal*.)

Variety.	Grower.	Acreage.
Cross 7	*Armstrong, F. G., Tycho, R.M.D., Timaru	15
	*Canterbury Seed Co., Leeston	10
	*Coughlan, M., Kingsdown, Timaru	11
	*Dickson, A. M., St. Andrews	7
	*Grant, A., Waimate	20
	McLeod, P. N., Sutherlands R.D., Pleasant Point	19
	*McMaster, H., Cave, South Canterbury	10
	*Mulholland, W. W., Darfield	10
	Selbie, G., Claremont, Timaru	9
	*Wolff, R. G., R.M.D., Rangiora-Bennetts	25
Dreadnought	*Cooper, W., Kakanui, North Otago	52
	Corrigan, J., Linkwood, Hook	10
	Coughlan, M., Kingsdown, Timaru	14
	*Evans, H., Section 6, Kauru Hill R.D.	29
	Gray, G., Uritane, Waimate	20
	*Manson, D. J., Enfield, Oamaru	12
	*Morrison, J. L., Morven	19
	*Newlands, G., Kauru Hill R.D.	31
	*Stevenson, W. S., Incholme R.D.	11
Hunters II	*Bowie, J. H., Otaio, South Canterbury	20
	Campbell, J., Albury, South Canterbury	20
Solid Straw Tuscan	*Blank, E. C., St. Andrews	5
	*Casey, J., Claremont, Timaru	10
	Craig, A., Greenfield, South Otago	9
	Davey, A. J., Waitohi, Temuka	7
	*Frewn Bros., Waimate	4
	Jones, J., Waiwera South	26
	Robinson, J., Springfield Road, Milton	10
	Tutton, F. A., Springston, R.M.D.	8

* Passed subject to machine-dressing of seed.

—*Fields Division.*

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SEASONAL NOTES.

THE FARM.

General Pasture Work.

In many districts pastures, especially ones containing a substantial amount of well-nourished rye-grass, when closed towards the end of May or in early June, provide valuable fresh feed in late July and August. The amount of July-August feed obtainable in this way may be increased by the use of manures containing nitrogen such as ammoniated superphosphate or sulphate of ammonia. The results from nitrogenous fertilizing are best when phosphates are applied just shortly before or at the same time as the nitrogenous material: the results from nitrogenous material used alone are likely to be disappointing. On soils which are known to respond to lime, liming should be associated with the use of sulphate of ammonia. Further, in certain cases where no visible benefit follows the use of lime either alone or in conjunction with phosphates liming has been found to beget better results from sulphate of ammonia. Because of this, even when there is doubt whether liming as a general practice is economic, it is, as a rule, in the absence of definite evidence to the contrary, advisable to lime when using sulphate of ammonia either by itself or in the form of ammoniated superphosphate. Whether the use of nitrogenous manure in this manner proves profitable depends on a number of circumstances, such as the type of pasture, the gravity of the need of the additional feed, the cost of alternative supplies of additional feed, &c. Hence no general recommendation about the advisability or otherwise of using nitrogenous fertilizer can be made.

Certain pastures are more suitable than others for providing late winter and early-spring feed. These are the ones which are well drained, which contain a considerable amount of rye-grass, and which possibly also are provided with shelter. A special endeavour should be made to harrow and top-dress such pastures in good time, as the additional early feed thereby obtained is likely to be specially valuable.

Almost invariably harrowing of dairy pasture is not carried out often enough to secure the fullest fertilizing effect from animal excreta. Possibly more attention would be given to this matter were it realized that in a year the excreta of a cow of 1,000 lb. live-weight, giving 350 lb. of butterfat, have been estimated to contain the equivalent of about one standard-size sack of 44 per cent. superphosphate, 7 cwt. of sulphate of ammonia, 1 cwt. of carbonate of lime, and 3 cwt. to 4 cwt. of 30 per cent. potash salt. If droppings remain long undisturbed there occurs not merely waste of much of this potential fertility, but positive harm from it. Such waste and harm can be avoided only by harrowing frequently enough. The point of direct importance is that, to many farmers who possess both harrows and the power to draw them, more frequent harrowing will not involve more direct outlay, but it will lead to a feed-supply of greater size and of better quality.

If at this stage any pastures are showing evidence of infestation of grass-grub, then when possible hay, roots, and silage should be fed out on them: the grubs seem to suffer from the resultant additional treading. A certain amount of resowing may occur from seeds contained in the hay and thereby bring about thickening of swards weakened by destruction of plants, and consolidation of the soil appears to facilitate the replacement of the parts of roots damaged by the grubs.

Pre-winter Top-dressing.

Any top-dressing that still remains to be done before the spring should be done as soon as possible: the special advantage of pre-winter top-dressing is to some extent lost if it is done when the soil is so cold that pastures have practically ceased growth until the arrival of spring conditions. Because the date of commencement of this cold period varies according to location, it is impossible to give guidance generally applicable, but as a rule no avoidable delay in top-dressing should now take place.

Although, if it is at all possible, top-dressing should be carried out before the advent of the most inactive period of pasture-growth, it may be advisable at times to top-dress during this period as an alternative to the inconvenience, and, possibly, inefficiency, resulting from an unduly heavy rush of work in the spring. The effect of phosphatic manures applied when the pastures are practically dormant is delayed as distinct from lost. The same is held to be true in general of lime and of potassic manures. But it is different with soluble nitrogenous manures: if conditions unfavourable to growth prevail for any considerable time after the application of such manures the value of the benefit obtainable from them, judging from considerable field experience, is substantially lessened.

Generally it is not advisable to apply soon after each other lime in any of its forms and any of that group of chemically similar phosphates which includes raw rock phosphates, Island phosphates, and African phosphates. These phosphates are all relatively slow in their action, and become more markedly so when used on land which has received lime. Liming carried out in close proximity to the application of basic slag may be expected to reduce the speed of action of the slag. When lime and phosphates are to be applied separately in the same season it may be taken as a general rule that it is preferable to do the liming first.

Farm Drainage.

In general, winter proves the most suitable season in which to attend to farm drainage. A point of prime importance that sometimes seems to be overlooked is that outlay readily may be wasted at least partially on drainage—even on that of land requiring draining—unless the work is planned and carried out in a careful manner. In planning a drainage system the first matter that should be determined is the source of the excessive supply of water. The determination of this may indicate the possibility of adopting the less costly course of draining an area by preventing water reaching it instead of by removing water after it has reached the area. Wet areas along hillsides or at foothills often offer opportunity for the use of drains placed to intercept water in the passage to badly drained land. As a rule, the first few pounds spent on drainage return the greatest percentage of profit: hence there is no justification for putting off drainage improvement of an area until a complete drainage system can be provided. Often the drainage of wet spots in a field is the most profitable drainage work a farmer can undertake. This is particularly true of land used for arable crops. In the drainage of isolated wet spots, especially if tile drains are being installed, an endeavour should be made to locate the drain-lines in such a way that they may serve as part of any more comprehensive future work, and probably be the basis of it.

Apart from low-lying water-logged soils which obviously are in a badly drained condition there are in many parts of New Zealand heavy retentive soils which would give quite profitable returns from judicious outlay on drainage. Mole drainage, because of the comparatively low cost, will be utilized with profit in the future over much greater areas than any other form of drainage. In many areas a firm clayey subsoil occurs just below the surface soil. Land of this formation is well suited for mole drainage.

Formation of Mole Drains.

Only brief mention of matters at times dealt with inefficiently is here possible: detailed information may be obtained from local officers of the Fields Division.

The formation of mole drains is usually best done in early winter after the first heavy rains have well moistened the subsoil. If the subsoil is too dry when the mole-plough passes through it, the walls of the drain may be cracked, and this is likely to lead to eventual premature failure of the drain: on the other hand, if the subsoil is too wet, a glazed wall on the mole drain may result, and this is considered to bring about slower passage of the water from the soil into the drain. Further, to mole drain early in the winter is at times advantageous because the considerable amount of wet weather that follows as a rule results in closing of the slits made by the blade of the mole-plough. Instances are on record in which drains were rendered quite useless when a period of dry weather occurred relatively soon after the somewhat late drawing of the drains: in the dry weather the slits made by the blade of the mole-plough cracked open, the soil crumbled and fell into the drain and silting-up ensued.

Mole drains up to 8 to 10 chains long as a rule give good service, and they may safely be made somewhat longer, provided there is a good and uniform fall throughout their length. Mole drains are not suited for use on extremely level ground, but they work satisfactorily when there is a fall of 3 in. to 4 in. to 100 ft., and so it is seldom necessary to rule them out on account of lack of fall. It is not advisable to establish mole drains on a steep grade, for too rapid flow of water causes the sides of the drain to scour away, and this may readily lead eventually to the collapse of the drain. It is particularly advisable to avoid in mole drains level sections or depressions, which bring the danger of gradual silting and eventual blocking of the drains. Hence, since the fall of the drain follows the contour of the surface of the land, it is advisable to go round instead of across depressions.

The drawing of mole drains should be done at a slow steady speed. The more quickly the plug of the mole-plough passes through the subsoil the more likely it is to break the walls of the drain, which hastens crumbling. The use of a powerful tractor may result in the carrying-out of the work at too great a speed—what is an excessive speed depends to some extent on the type and the condition of the subsoil—it is reported that particularly poor results have followed speeds of $3\frac{1}{2}$ to 4 miles an hour.

Mole drains usually are placed at a depth of 17 in. to 20 in. The top of the drains should be about 2 in. in the subsoil: if the drains are not below the more open relatively crumbly surface layer their period of service will be greatly reduced. On the other hand, they should not be placed more deeply than ensures avoidance of the comparatively crumbly surface soil: the deeper they are in the retentive subsoil the slower will be drainage—a distinct disadvantage. It is important to keep in mind that the depth of mole drains should be determined not by the average thickness of the more open surface layer, but by its greatest thickness: if this were overlooked the mole drain would collapse, after a relatively short time, in those parts of it that passed through surface soil where the layer of it happened to be deepest. Any such collapse would render a part at least of the drainage system ineffective.

The distance between the mole drains is to some extent a matter of choice: in practice it is seldom if ever less than is profitable, while often the drains are too far apart for fully economic service. The heavier the texture of the land the closer should be the drains. Usually it is not advisable to place mole drains farther apart than 9 ft., and often better and more profitable results would be obtained from drains 6 ft. apart on the more tenacious clays.

Like other drains, mole drains do not work properly unless they are kept open at the mouth. Mole drains may discharge—(1) along a natural hillside or terrace, (2) into open drains through firm subsoil, (3) into intercepting tile drains, (4) into intercepting larger mole drains, which serve as main drains. When mole drains discharge along a hillside or terrace, the openings often are in soil or crumbly subsoil, which usually provides a very inadequate outlet unless proper measures are adopted. One means of dealing with this position is to dig a trench at the mouth of each mole drain until solid subsoil is reached and then to lay tiles from this point to the point of original discharge and fill in the trench. It is not satisfactory merely to lay a tile or two at the opening in the subsoil and to have the mole discharging into an open trench, for the latter is likely to become blocked by the treading of stock. When the mole drains discharge through firm subsoil into open drains, it is necessary simply to attend at suitable intervals to the removal from the mouths of the mole drains of material apt to hinder discharge. When discharge of mole drains is to be carried away by intercepting tile drains, the tiles should be placed at a depth which would allow the mouths of the mole drains to discharge at the same level as the top of the tiles. It is preferable to form the mole drains before the trenches for the tile drains have been opened, but the opening-up of the trenches for the tiles should be carried out as soon as possible after the drawing of the mole drains. By avoiding delay in this respect one eliminates the danger of material collecting in the mole drain in the vicinity of where it crosses the tile drain. When the intercepting tiles are being laid, it is advisable to establish a connection between the mole and the tiles by suitably placing a grass-sod against the side of the open trench immediately above the mouth of the mole and across to the tile. When a larger intercepting mole drain serves as a main drain, the main should be drawn first, otherwise in drawing the main the blade of the mole-plough will close up the mouths of the smaller intercepted mole drains. The intercepting larger mole drain should be at such a depth that while it is below the others it connects with them. When the smaller mole drains just break the top of the larger intercepting mole drain, the junctions have proved satisfactory. Sometimes, however, it is found necessary to pierce the ground at the junction or to open up the junctions to obtain a free passage from the smaller drains into the main mole drain. Sometimes obstructions occur in mole drains. They originate most commonly in "hard-pans" in the ground. The plough either rises and rides over the "pans" or it penetrates them and produces rubbly material which does not give a permanent passage for the movement of water. They may also originate in sandy "pockets" in the subsoil. In either case the location of the trouble is indicated when the water "wells up" to the surface at the point where the drain is blocked, and the correct practice is to open up and tile carefully the affected section of the drain so as to obtain a continuous passage.

Crop Utilization.

On many farms the pulling and storing of mangels should be carried out in June, especially if the mangel area is required for another crop, such as oats, to be sown soon. But rules about the pulling of mangels cannot be laid down for general application: in some milder districts mangels continue increasing in weight beyond the date at which they cease growth in other districts. It is doubtful whether it is advisable to pull the mangels in these milder districts early in June if they are not to be used until late August or September unless the land they occupy is especially required for some other crop, or likely to become so wet later that it will be difficult to cart the crop. However, if the crop is to be fed to stock earlier than has been mentioned above it should be pulled in good time to allow it to ripen or mature before the stock consume it. Freshly pulled mangels are more subject to frost injury than those still in the ground and those that have been pulled for a few days, and so, if at all possible, broken weather should be selected for pulling.

Many sheep-farmers successfully utilize mangels relatively late in the season without storing them: broken-mouthed ewes are put in to eat off the tops, then the roots are harrowed out in breaks some days prior to the sheep being given access to them. If the mangels are to be pitted, the practice of throwing the roots into small heaps, covering the heaps with leaves removed from the roots, and leaving them for a few days before carting is favoured by some who hold that roots left in such heaps for upwards of a week before carting keep better.

The winter-feeding of stock wholly or almost so on roots is undesirable: stock so fed receive a diet which is badly balanced, too watery, and too cold. Heavy root-feeding is especially unsuitable for old toothless ewes if the roots are offered intact. Heavy root-feeding to any type of breeding-ewes, to dairy cattle, or to pigs has definite weaknesses. Roots may be supplemented suitably with dry fodder such as hay or chaff for cattle and sheep, and with grain or meal for pigs. The quantities of each class of feed to use depend to a considerable extent on various circumstances, such as the feeds available and the amount of "keep" the stock can obtain from pastures. Detailed information relative to specific cases may be obtained from district officers of the Department of Agriculture.

Guidance as to the feeding of silage is provided in the fact that 1 lb. of typical silage equals in feeding-value approximately 2 lb. of roots, and 2 lb. to 2½ lb. of silage is equal in feeding-value to 1 lb. of average good hay. This generalization is subject to the qualification that the materials differ somewhat in their suitability for specific purposes—*e.g.*, roots well can be recommended for pigs, whereas silage normally cannot. Probably the commonest mistake in the feeding of silage originates in attributing to it a feeding-value much greater than that which it actually has, with the result that stock suffer, not from any undesirable or harmful characteristic of the silage as some unwarrantably have assumed, but from semi-starvation, just as they would upon a half-ration of hay or grass. Under New Zealand conditions it seldom should be necessary to attempt to feed to dairy cows more than 40 lb. of silage daily—up to approximately 100 lb. daily has been fed with success—and usually less than 40 lb. will suffice in conjunction with the feed provided by the pastures. Silage has been fed with good results to sheep, when used to supplement pastures, at the rate of about 2 lb. daily.

—R. P. Connell, Fields Division, Palmerston North.

THE ORCHARD.

Pruning Operations.

With the commencement of winter, a start may be made with the pruning, taking the different classes of fruits in their order of leaf-fall. As stone-fruit trees usually lose their foliage before pip-fruits, it is the practice to commence the winter pruning on these.

It is impracticable in these notes to set out detailed instructions on pruning which would be applicable to all districts and which would suit the conditions of all trees. It is necessary for the pruner to have a grasp of the main fundamental principles governing the production of healthy foliage, extension of growth, and fruiting wood. Provided these are kept in mind, the detailed application may be varied to suit local conditions.

Herein notes about the treatment of stone-fruits are given, and in next month's notes the pruning of pip-fruits will be dealt with.

The mature tree should be strong and have sturdy leaders and fruiting arms, which should be well spaced to permit of the free circulation of air and the penetration of the sunlight so needful in the development of healthy buds and young growth, and for the ripening and colouring of the fruit.

With well-spaced leaders and fruiting arms, the spraying of the tree is also rendered much easier and more thorough, with a consequent better control of diseases and pests.

With young trees the paramount aim is to secure vigorous well-built trees which will be capable in future years of carrying heavy crops. The development of the framework and fruiting arms must receive first consideration. If the trees are weakly they should not be permitted to carry fruit until they become reasonably vigorous. In some instances it is time enough to start fruiting them when the building of the framework has been completed.

The leaders should be selected early, and the number of leaders to select varies with the fancy of the grower. There are some growers who contend that three leaders are sufficient, and others who fancy from sixteen to twenty. The danger of having a large number of leaders is that of overcrowding and producing a dense mass of foliage to the detriment of fruiting.

Where stone-fruit trees are planted on good soil, they are as a general rule very vigorous growers. It is the practice of some to hard-prune these vigorous young trees by cutting the leaders well back. Such hard cutting of the leaders promotes a profuse mass of growth the following summer, causing overcrowding, and, in consequence, the non-maturing of a large number of the young shoots, unless summer pruning is resorted to. During the following winter a large number of heavy rank growths produced have to be cut away because they are not of any use and are competing with the leaders. Where such hard pruning is practised each winter, a great deal of waste growth is produced each year with no benefit.

Once the leaders have been selected, it is preferable, providing that growth is vigorous, to leave the leaders uncut, shortening back any side-shoots on this last annual extension of the leaders and thinning out the balance of the young growth. By this method the energy of the tree is absorbed by the leaders, which respond with further extension of the growth, and at the same time greatly increase the circumference of the limbs and branches. A larger and stronger tree is built up in a shorter time by this method than by hard cutting, as the growth of the tree is fully utilized and not lost in the production of waste growth.

Peaches and Nectarines.—The fruiting habits of the peach and nectarine are identical. The crop is produced entirely on one-year-old wood, and a heavy thinning-out is necessary each winter in order to maintain a constant supply of fruit-bearing wood. Unless an abundance of good vigorous shoots is being produced each year, the tree may be considered to be in an unthrifty condition, and to require added attention from the manurial and cultivation standpoint to maintain its vigour.

All dead and diseased wood should be removed, as also all unmatured laterals in the centre of the tree. All unbranched light two-year-old laterals should be cut away, and the remaining one-year laterals thinned out to prevent overcrowding. It is generally advisable not to shorten the one-year growths—either leave them uncut for fruiting or remove them entirely. It is preferable to leave the well-ripened stocky laterals rather than the slender shoots.

The main aim should be to remove sufficient of the wood each winter to maintain the required amount of growth the following season, and also to keep the fruiting wood well spaced throughout the tree.

Apricots.—The bulk of the fruit of the apricot is carried on relatively short-lived spurs. The treatment should be such as to cause the continual renewal of the fruit-spur system. Each winter fairly heavy thinning of the spurs is desirable to maintain sufficient vigour in the tree, and also to prevent overcropping.

Cherries.—The fruit is carried on long-lived spurs. A better class of fruit, however, is produced if a gradual renewal of these spurs is encouraged. To accomplish this, from 10 per cent. to 15 per cent. of the fruiting wood should be renewed each year.

European Plums.—The fruit of the plum is mainly carried on short spurs and laterals of two years and older. The treatment suggested is the gradual removal of the older spurs and laterals and their replacement with younger fruiting wood. Approximately 20 per cent. of the fruiting wood should be renewed each season.

Japanese Plums.—These plums are generally prolific bearers, the fruit being borne on laterals produced during the past season, as well as on short spurs and laterals of two years and over. The finer class of fruit is carried on the wood of from two to four years of age, and the treatment suggested is the renewal of 25 per cent. of the fruiting wood each year. Fruiting laterals should be encouraged, and the annual growth left uncut where required for fruiting, otherwise it should be removed altogether. Because of the tendency of this plant to overcrop, the clusters of spurs should be well thinned out.

All prunings should be gathered and destroyed, and not left lying around.

—*R. G. Hamilton, Orchard Instructor, Hamilton.*

Citrus Notes.

Should much rain occur during the month of April, the possibility of frost injury to young growth should not be overlooked. In those parts of the district where frosts are likely to be experienced, measures should be taken by growers to protect their trees.

Wet weather at this period favours the development of brown-rot. To prevent the spread of this disease all branches should be removed to a height of at least 3 ft. from the ground and all infected fruit destroyed, while the ground beneath the trees should be kept cultivated, so as to maintain a somewhat dry soil-mulch, as fructifications of brown-rot are produced only when the soil is sufficiently moist. The spores of dry-rot develop on the surface of the soil, and may be splashed on to the tree by rain. The maintaining of a cover crop about the trees is recommended as a means of preventing this.

The time for the harvesting of citrus fruits is approaching. Lemons are best gathered when they are green or silver, and have attained a size of 2¼ in. to 2½ in. in diameter, so that they may pack from 150 to 200 per bushel case.

Poorman oranges should not be gathered until they have become "tree-ripened," unless required for the purpose of making marmalade. The best method to follow is to divide the harvesting-season into two, the early (April to July) picking being used for marmalade, while the pectin (the jelly-making material) content of the fruit is at its maximum; and those remaining left until later for use as a breakfast fruit or for juice purposes. This fruit through being left on the tree until fully matured has become very popular in recent years.

Sweet oranges should be allowed to mature on the tree so that they may develop their full flavour and sweetness. It is only in this way that the local-grown sweet orange will be appreciated by the consuming public.

The greatest care must be exercised in handling citrus fruits in order to avoid injury, as it is through the damaged cells that the spores of various organisms which cause fruit-rots gain an entry to the tissues of the fruits. It is mainly through injuries caused in handling that such a heavy annual percentage of wastage occurs. Every one who handles fruit should make a special effort to handle it more carefully than they have done previously. If this were done it would help considerably in the marketing problems which confront the industry.

—*L. Paynter, Orchard Instructor, Auckland.*

POULTRY-KEEPING.

Overhaul of Plant.

As the present time is what might be termed the poultry-keeper's "slack" period, it affords an opportunity to give the whole plant a good overhaul, so that everything may be in good order for the coming busy season.

Repairs to fences, gates, nests, feed-troughs, perches, &c., should be given attention. In fact, if a prompt and regular system of repairs were adopted on all plants, the heavy expense of replacement would often be saved. Many poultry-runs would be much improved by ploughing or digging and the sowing of a green crop such as oats, barley, or mustard. If a run is at all tainted, and it is not convenient to turn it over, it is a wise plan to give the ground a good dressing of lime to the extent of about 1 lb. of lime to each square yard. Some poultry-keepers fail to realize how much improvement birds show when on fresh sweet ground. No farmer would expect his sheep to do well if kept in the same paddock year after year, yet poultry are often compelled to live in the same small yard long after the ground has become tainted and fowl-sick.

When erecting a poultry-house, it is advisable, if possible, to provide for two runs, so that they may be used alternately and sweetened regularly. If this were done, such trouble as worm-infestation and other troubles attributable to stale ground would not be so prevalent.

Some Ailments.

A correspondent inquires about the cause of pullets breaking down and at times bleeding to death.

This trouble is what is known as protrusion or prolapse of the oviduct, and is really due to a weakness of the muscular portions of the walls of the oviduct, which makes the oviduct unable to stand the strain of great egg-production. At times it would appear that this weakness is inherited, as plants have been visited where pullets bred from certain males have shown a marked tendency to this trouble. Also it may be brought on by feeding too much animal food, such as meat, meat-meal, or milk, and on occasions the bleeding is caused by other hens pecking at the oviduct just when a hen is in the act of laying. This often brings on a hæmorrhage, and then the other hens in the flock will also pick at the bleeding part. If such is the case, it is well to darken the nests by tacking scrim or sacking in front of the nests, or make the nests so deep that the oviduct of the bird cannot be seen or picked at when laying. When this trouble first starts in a flock it is advisable to keep a close watch on the birds for an hour or so during the morning, and often the culprit may be seen walking along the front of the nests waiting for a chance to pick at other birds when laying. If these birds are detected and removed from the flock, further trouble may be checked.

While protrusion of the oviduct is often brought on by the feeding of too much animal food, cases of cannibalism have been known to have been caused by pullets not being fed sufficient animal food. It is well, therefore, when this trouble starts in a flock, to make every effort to find the cause and to remedy the conditions. A regular supply of succulent green feed, the feeding of a little more grain and less mash, the addition of one packet of Epsom salts to each gallon of drinking-water every second day until the trouble is checked, and the increasing of the amount of litter in order to encourage exercise, is a suggested treatment.

Egg-eating Habit.

Most hens will greedily eat eggs if any get broken, and this annoying habit is often the result of eating a thin-shelled egg that has been broken

when laid on the ground or in a nest which has not had sufficient nesting material in it. At times a male bird has been known to start the trouble, and where such is the case he should be removed from the pen. Experiments have proved that hens will lay just as many eggs when running without male birds, so unless the eggs are required for hatching purposes there is no necessity to keep male birds.

Like many bad habits, egg-eating is more easily prevented than cured. A sufficient number of nests should be provided—*i.e.*, one nest to each four or five hens, and plenty of nesting material such as fine sand, *Pinus insignis* sawdust, pine-needles, or soft straw should be used. A cure has sometimes been effected by supplying the birds with a number of nearly whole fresh egg-shells. If a local baker is asked to save, say, a half kerosene-tin full of fresh egg-shells, and these are placed near the nests, the hens may eat so many that their appetites for eggs may be destroyed.

Double-yolked Eggs.

These are caused by two yolks entering the membrane-secreting portion of the oviduct, or egg-tube, at the same time. This ailment is more common when pullets are starting to lay, and some birds have a tendency to produce such eggs. The trouble is not so frequently observed in older birds.

If a number of double-yolked eggs are produced by a flock, it would indicate overfeeding, especially with meat, meat-meal, or condiments, and slight adjustments to the ration should be made. However, if only one or two birds are producing such eggs, it is not advisable to make any change in feeding methods, but if the particular bird or birds can be detected and given a dose of Epsom salts (about one-third of a teaspoonful dissolved in water), it should correct matters.

Soft- and Thin-shelled Eggs.

This trouble is usually more noticeable towards the end of a heavy laying-season, when the egg-laying system of birds is becoming more or less exhausted. The immediate cause is the failure of the shell-forming portion of the oviduct, or egg-tube, to function properly. Soft-shelled eggs are at times dropped as the result of birds being chased or frightened. The feeding of too much animal food or condiments has a tendency to cause this trouble. As the want of shell-forming material is at times a contributing factor, it is advisable to see that a plentiful supply of oyster-shell grit is always within reach of the birds. The addition of 1 per cent. of oyster-shell dust to the mash will sometimes improve matters. Finely broken-up burnt bone placed where the birds can help themselves is useful.

Simple overfeeding will cause the production of poor-shelled or badly shaped eggs, and as a remedy more exercise should be given by increasing the amount of litter, thus making the stock work for their grain. However, if a large number of thin-shelled eggs is being produced, it would indicate that the constitution of the strain is going back, and perhaps some fresh blood is required.

Blood Spots in Eggs.

On occasions small spots of blood or blood streaks are found in fresh eggs. When such spots are found in the yolks it is the result of a rupture of a small blood-vessel in the ovaries, and if found in the white it is usually due to trouble in the oviduct. Perfectly healthy hens will at times produce such eggs, especially if fed rather too much animal food during the spring of the year. These troubles are usually more common during the spring at the peak period of the laying-season, when spices or somewhat too much animal food is being fed. As a remedy it is well to slightly reduce the supply of animal food during September, October, and November,

and if condiments are being fed it is advisable to discontinue their use, as they often cause irritation. The addition of a little Epsom salts to the drinking-water, about two tablespoonfuls to each gallon, should have a good effect.

The only way to prevent such eggs from being exposed for sale is to test or candle all eggs before sending them to market.

—C. J. C. Cussen, Chief Poultry Instructor, Wellington.

THE APIARY.

Winter Precautions.

BEFORE the cold weather sets in every hive should be examined in order to make sure that the frames are completely covered with sufficient dry, well-fitting mats to keep the bees protected. Wherever a damp or mouldy mat is discovered it should be replaced with a dry one, and the roof examined and repaired. No draughts should be allowed around the frames. Mats made of corn-sacks cut to the exact size of a zinc queen-excluder answer all requirements of warmth. Care should be taken to ensure that they are placed in their exact position. If placed crookedly the edges are apt to be pushed out between the hive-body and the roof, and when this occurs they in time absorb enough moisture to make them damp and unwholesome.

Once more the time approaches when the necessity for shelter should impress itself on the beekeeper. It is most essential that the bees be protected from cold winds during the winter. Should no permanent shelter be available, something temporary should be erected if the bees are expected to prove in normal condition in the spring. Manuka-scrub is excellent for making a temporary wind-break.

Weeds and grass should be kept down. A good clearing round the hives in autumn suffices until spring, and adds materially to the comfort of the bees and the well-being of the hives. Not only should the entrances be cleared, but the ground all round the hives similarly treated, and the weeds raked up and destroyed.

Care of Hives.

At no other season is the welfare of the hives of such importance as during the next few months. Every hive should be raised from the ground to the height of one brick, and if the situation is damp or low-lying it is a good plan to raise the hives still more. This tends to keep them free from slaters (wood-lice) and other insects, affords less harbour for mice, and ensures that the hives have a free current of air beneath the bottom-boards and are thus more likely to keep dry. The bottom-boards should not rest on the ground, where they rot in very short time and become mouldy and evil-smelling.

Before bad weather sets in it is a good plan to give a coat of paint wherever it is needed, at the same time stopping up all cracks in the supers. Cracks afford ventilation during the summer months, but they are hardly to be advocated on that account, because the beekeeper will usually find that towards the end of the honey-flow the bees will use much valuable time in gathering propolis to paste up the cracks in view of the approach of winter. The hives should be slightly canted forward, so that any rain which falls on them may drain off the alighting-board.

Apart from disease, there is no worse feature in an apiary than the presence of leaky hive-covers. A roof which allows moisture to trickle through is a constant menace to the colony it appears to shelter. Not only will the mats immediately beneath it become sodden and mouldy, but the cluster of

bees in the hive stands in danger of extermination when frost sets in. There is no excuse for leaky covers. In the autumn the apiarist should examine them for any weak spots, and should cover them with zinc, ruberoid, or some other water-proof material. If economy must be practised, he may cover with cheesecloth, applying to the roof first a coat of paint, then the cheesecloth, and then another coat of paint. This makes an effective water-proofing, and one which anybody can apply.

Plans for next Season.

During the off-season is the best time to make plans for the following season. The beekeeper should decide what increase he desires to make, and should prepare accordingly. Making up hives and frames is exasperating work if left till the bees are badly in need of room, and it should be finished long before the actual time for increasing one's stock arrives. The beekeeper should also face the question of providing himself with stocks of foundation, and make arrangements for the treatment of his surplus wax by some neighbouring maker of foundation. He should also decide on which market to place his crop, and lay his plans accordingly. It is advisable, too, that he consider the theoretical side of his occupation, and, while the bees are in a dormant condition, study the best methods of improving his stocks. Neither weather conditions, locality, nor any other factor influences the honey crop so much as strong colonies of bees, and the apiarist should endeavour, while he has the time, to ensure these during the following summer.

—E. A. Earp, Senior Apiary Instructor, Wellington.

HORTICULTURE.

Soil Fertility.

THE successful production of vegetables, or other herbaceous crops, and small fruits depends chiefly on the selection of suitable land and climate; providing what shelter and drainage may be necessary; and, after preparing the land by cultivation and manuring, planting seeds or plants of the best available varieties and strains.

Soil and climatic conditions required by the various crops differ so widely that any land of fair to good quality that is easily ploughable will produce these commercial crops of one kind or another if the problem of transport to markets is satisfactory. The limit then is market demand, which is best maintained by regular supplies, evenly distributed. In many instances, in the opinion of some authorities, the demand may be greatly extended by presenting the goods in a more convenient manner and judiciously advertising them.

The type of land which is heavy, acid, and lacking humus is fairly common, and in preparing it for horticultural crops it requires deep cultivation at intervals, probably every third or fourth year, by double ploughing in such a way that the topsoil, which is the more fertile, is not buried. To obtain the desirable friable state and to retain moisture, in addition to supplying plant-foods, farm manure or green cover-crops are ploughed under and a dressing of finely ground limestone, carbonate of lime, is broadcasted and harrowed in. To obtain the best results the limestone should be finely ground, so that the greater part of it at least will pass through a sieve with sixty meshes to the linear inch. In the absence of local data it may be applied at a rate of 1 ton to 2 tons per acre, or ½ lb. to 1 lb. to the square yard. Where land of this class has been brought to a fairly friable condition an annual dressing of ½ ton to the acre, say, ¼ lb. to the square yard,

suffices. To provide the necessary phosphates finely ground bonedust, 2 oz. to 4 oz. per square yard, may be ploughed under, or finely ground basic slag or rock phosphate may be used at the same rate.

This preparation should be done as early as possible in winter, when the land is in a comparatively dry condition. For supplies of nitrogen during the spring and summer sulphate of ammonia is the most suitable fertilizer on land of this class. Where further supplies of available phosphates are required during the growing-season, superphosphate may be used in moderate quantities. For most of the crops under consideration these fertilizers can be used on this land with best advantage only when the lime requirement has been supplied.

Other types of land of which there are considerable areas under horticultural crops are the light volcanic soils and more or less light alluvial soils. These are usually well drained and, when sheltered, are often suitable for early cropping. They are more easily managed, but, owing to oxidization and leaching, the consumption of manures and fertilizers is rapid and the land is sometimes spoken of as being more or less "hungry." The method of feeding crops on these soils is one that may be described as "little and often," especially as regards the more soluble fertilizers. Because of their friable nature early and deep cultivation in winter is not necessary, and, owing to the rapid disintegration of manures, is not desirable. Also, the demand for lime is not the same as in the case of the heavy soils, where it is required for its physical action of flocculating the clay particles to get rid of the tendency to form clods and surface crust. What such open soils chiefly require are generous supplies of humus turned in shortly before cropping and a good, well-distributed water-supply. A careful watch should also be kept to see that the crops on such soils do not suffer from want of potash, of which the form known as muriate of potash is often most suitable for this type of land; and nitrogenous top-dressings during the growing-season may consist of small periodical applications of nitrate of soda or finely ground fowl manure. Owing to the rapid consumption of fibre and humus under a system of heavy commercial cropping of these soils, the rotation should include a period at regular intervals when the land is sown down in grass and clover, and grazed.

Vegetable Crops.

Root crops, onions, &c., in storage should be examined occasionally to note their condition. Any sign of approaching deterioration should be dealt with immediately, either by adjusting the storage conditions to make them more favourable or expediting the distribution of the crop on the market.

The preparation of the land for early crops and such permanent crops as seakale, asparagus, and rhubarb should now be given every attention.

A commencement now may be made to raise tomato-plants for planting out under glass, and, somewhat later, half-hardy plants of different kinds for planting outside in early summer. These are usually raised on a hotbed formed of fresh stable manure in an active state of fermentation. This state is obtained by placing the manure in a compact heap, and, when fermentation is active, restacking the material, taking care to place that on the surface in the interior of the new stack, shaking out any matted portions, and watering with a fine spray any portions that are dry. In a few days, when active fermentation is again established, this treatment is repeated. Further turnings are given as required until the whole mass is in a uniform state of active fermentation, when the hotbeds may be made in a dry place that is well drained and sheltered. At the end of the season the manure is in a thoroughly decayed state and is in excellent condition for a potting compost or top-dressing for lawns.

Good reports are being received regarding the use of electric soil-heating cables in places where stable manure is not available for making hotbeds. The cable is composed of resistance wire, insulated with asbestos, lead-covered, and wrapped with tape, which prevents corrosion by chemical action. A 50-yard cable loaded at 700 watts usually is sufficient for a six-light frame, and with a thermostat the requisite heat can be maintained economically. For a single frame a 10-yard 200-watt self-regulating cable may be obtained: this maintains a temperature of 50°, 60°, or 70° F., as desired. As this cable is self-regulating, no thermostat is necessary.

The usual method recommended for establishing outdoors a bed heated in this manner is to remove the soil to a depth of 15 in., extending 1 ft. all round beyond the frame. Fill in with 8 in. of breeze or cinders for drainage and insulation, place the frame in position, and fill round the frame with the insulating material. Lay 1 in. of sand over the drainage inside the frame, and then place the cable in position. A further 1 in. of sand is laid over the cable and then covered with 1 in. wire netting to protect the cable. On top of this 6 in. or 8 in. of soil are laid for planting, or the ordinary seed-boxes may be used in its place. Considerable economy in power used will be obtained by insulating the sides of the frame and covering the lights on cold nights, also by choosing a warm, well-drained position. In an experiment carried out where cinders were not available for insulation, a sandy loam was used in its place with promising results. The cables mentioned above should have a life of at least five years.

The Pruning-season.

Pruning was dealt with in last month's notes in so far as it had to do with planting out young trees and shrubs, with a view to laying a foundation for the rapid development of a strong plant of a desirable design. Other phases of the operation of pruning are summer pruning, which not only has much to do with the shaping of the plant, but has considerable influence in restraining growth, which is a result sometimes desired when plants are over-inclined to run to wood when flowers and fruit are desired. Hedge-trimming and topiary work are a feature in some styles of gardening, also the removal of wood so soon as it has fruited in summer, as in the case of raspberries and loganberries, &c., which not only materially assists in controlling disease, but allows the new wood, which will fruit the following year, to ripen well. The dormant period, as the winter is sometimes called, is, however, the pruning-season in a special sense, as it is then that general pruning is done on most kinds of trees and shrubs that are highly trained, such as fruit-trees, bush fruits, roses, &c., as well as shelter and shade trees which may have been damaged or which for some other reason may require attention of this kind.

The pruning of fruit-trees is dealt with in the Orchard Notes of this *Journal*. Good pruning is generally done when one keeps in view two things —namely, the habits of the plant and the object in view. Roses and hydrangeas produce their blooms on new wood of the same season. Such new wood is best produced on strong, ripe growth of the past season. Such growth should be retained and shortened. If too much is retained the plant will become crowded with new wood, and the blooms will be small. Any growth which is not retained for producing bloom next season should be cut away completely. If sufficient strong ripe wood of last season's growth is not available weaker growth is retained, cut hard back, and nitrogenous manures are given.

Black currants and gooseberries produce their best fruit on young wood of last season's growth; accordingly the best of the wood of that type is retained in each bush. The wood which fruited last season if cut away now to a bud at the base will produce young wood which will fruit in its

turn. If anxiety for a big crop leads one to retain too much fruiting wood, the results then are small fruit, many scratches when picking in the case of gooseberries, and poor growth for future cropping. The art of all good pruning lies chiefly in thinning out the growth and shortening it back to just the right extent. Other shrubs, such as the red currant, bear flowers and fruit on spurs and small laterals. Such types should be well thinned out so that the leading growth on which the spurs and laterals are borne will have plenty of light and air so as to keep them in a healthy, fruitful condition. Thinning out the wood in these plants usually takes the form of removing completely many of the strong shoots formed during the last growing-season, more especially from the centre. Shelter-trees and shrubs generally, after the initial pruning at planting-time, require little attention of this kind: usually it consists of restraining those inclined to overgrow the position, repairing storm damage, or checking any tendency to abnormal growth. While the amount of work of this kind required may be small, it is of great importance in retaining effective shelter, developing the best qualities in a shrubbery border, and preserving valuable specimen trees. Among the more important features of the treatments are to cut the limb away flush at its point of origin, or just beyond a side growth or healthy bud, make a clean smooth cut at the right angle, and give all large cuts a good coating of tar or thick paint, which should be renewed annually as required.

—W. C. Hyde, Horticulturist, Wellington.

SPROUTED WHEAT FOR SEED.

I. D. BLAIR, Canterbury Agricultural College, Lincoln.

THE abnormally heavy rainfall throughout Canterbury early in the year caused severe sprouting of wheat standing in the stook, and even in the standing crop.

At the beginning of this new growing-season many farmers are concerned about the value of sprouted lines of wheat for seed purposes, and the problem is being investigated, but the complete results are not yet available. The following is some progress information for the benefit of the farmers who are sowing now.

A sample of sprouted grain was examined and the sprouted grains sorted into four classes, from the most severely sprouted—viz., all with green shoots over ½ in. long—to the least sprouted, where the shoot had just broken through. Laboratory germination of such grain after air-drying and after eight weeks in stack ranged from 58 per cent. to 96 per cent. When sown in the soil, however, the percentage establishment of seedlings ranged from 3½ per cent. to 45 per cent. where the sprouted seed had been air-dried. Where the grain had been stacked the germination of the seed in the soil was even lower. Undoubtedly no farmer would consider sowing such badly sprouted grain as was used in these trials, and by machine-dressing an ordinary sprouted sample most of the badly sprouted grains may be separated from sound unsprouted grains.

Some commercial lines of sprouted seed have also been tested. Laboratory and field germinations were lower than unsprouted seed. However, the field germination of such commercial lines of seed varied from 80 per cent. to 88 per cent., and such seed is quite satisfactory for seed purposes, especially if a few more pounds of seed per acre than usual are sown.

These conclusions have been reached as a result of sowing the samples in early April. When the results of the May sowings are available a detailed account of the investigation will be published.

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith. Letters should be addressed to the Editor.

TREATMENT OF WORMS IN CATTLE.

J. F., Towai :—

Trouble is being experienced with young stock suffering with worms. The animals affected are six-months-old to eighteen-months-old heifers and steers. Could linseed oil and turpentine suitably be used ? Is it mineral or vegetable turpentine that is used ? Can bluestone and mustard suitably be used for controlling worms in cattle ? What quantities of the above drenches are used for young cattle ?

The Live-stock Division :—

It is advisable to use bluestone and mustard rather than turpentine and oil, as the worms usually found are the small stomach worm. All stock should be drenched whenever they are weaned, and in badly affected cases treatment should be applied every month if this can be done. Dissolve 2 oz. of bluestone and 2 oz. of mustard in 1 gallon of water ; use an enamel or porcelain container—do not use a metal container such as one of iron. To six-months-old cattle give 8 oz. of the solution ; to eighteen-months-old cattle twice that dose. Eighteen-months-old animals are not so likely to be " wormy."

In addition, it is advisable to feed some hay, crushed oats, and bran, and allow access to rock-salt.

THROAT-TROUBLE IN FOWL.

D. M., Wanganui :—

A fowl has throat-trouble. She makes a noise such as fowls do when eating wheat too quickly. Her comb has gone a purple shade, and she has not laid well since she developed this trouble. She coughs more in the heat of the day than she does at night. Could you advise me what is the matter and what treatment to give ?

The Live-stock Division :—

From the symptoms given, and without examining the bird, it is impossible to state with certainty what the trouble is. It may be a case of simple catarrh, bronchitis, influenza, a small tumour in the air passage, or, again, the heart may be the cause of the trouble. However, it is advisable to separate it from the rest of the flock and treat as follows : Give ½ teaspoonful of Epsom salts dissolved in water. If the eyes, nostrils, or mouth are affected they should be washed with warm water containing 1 teaspoonful of common salt to the quart. The air-passage should then be disinfected with a 3-per-cent. solution of boracic acid. This can be done by injecting the solution into the nostrils with a small syringe or a medicine-dropper.

If the bird does not recover in a few days' time, you should destroy it.

METHOD OF ASSESSING LAMBING PERCENTAGE.

R. F., Oamaru :—

What is the generally recognized method of stating a lambing percentage in a case such as the following : 1,000 ewes to rams, 50 ewes die during winter, 50 ewes are dry, 900 lambs are born, 800 lambs are tailed ?

The Live-stock Division :—

The method of arriving at the lambing percentage is to take the number of lambs tailed against the number of ewes put to the ram. In the case you cite, 800 lambs were tailed out of 1,000 ewes put to the ram, which is equivalent to a lambing percentage of 80.

WEATHER RECORDS: APRIL, 1936.

Dominion Meteorological Office.

NOTES FOR APRIL.

FOR the first eighteen days the weather in April was warm with an absence of wind, and, except in western and southern portions of the South Island, there was very little rain. In consequence, stock and vegetation thrived. At the end of the month there was abundance of feed available. During the first part pastures hardened considerably in most districts, and for the first time this year lambs began to fatten well. Cold, wet, and stormy weather after the 18th, however, caused a setback. The milk-yield was well maintained for the time of year, but is now falling off.

Rainfall.—The rainfall distribution was irregular. On the west coast of the South Island it was below normal, while in coastal areas between Kawhia and Foxton it was mainly above. In other districts there was much variation, some stations having more and some less than the average. The latter were somewhat the more numerous.

Temperatures.—Temperatures were considerably above normal in all districts, the departures being generally in the neighbourhood of 1·5° F. There were few frosts, and none severe. Snow is rather unusually thick and low on the mountains for the time of year.

Sunshine.—As regards sunshine, the reports to hand indicate rather variable conditions. In the North Island, Napier, with 208·2 hours, had a sunny month, as also did Tauranga. At New Plymouth and Wellington there was rather less than the average. In the South Island, Marlborough totals exceeded the average, but elsewhere the month was a cloudy one. This was particularly the case in eastern districts, where there was a prevalence of low cloud, and a number of fogs were experienced.

Pressure Systems.—Until the 18th, pressure was generally high over the Dominion, and although a number of shallow depressions passed they were responsible for little rain except on the west coast of the South Island. The most active one passed on the night of the 2nd. It caused fairly widespread rain, with some heavy falls in Westland, Southern Otago, and Southland.

On the 18th a depression moved down from the north, and, crossing the Auckland Peninsula, developed a small but rather deep centre north of the Bay of Plenty on the 19th. Gales blew round the centre, but elsewhere the winds were not strong. This storm continued to move southwards, and when east of the South Island it was reinforced by a series of westerly depressions which advanced across the South Tasman Sea. Pressure continued to fall until the 23rd, on which day there were north-westerly gales from Cook Strait southwards, some damage being done in Canterbury. From the 19th to the 25th most places had rain every day, and there were many heavy falls, especially on the 22nd and 23rd. As the last of the series of depressions passed on the 24th and 25th, a cold snap occurred, and there were many hailstorms. Thunderstorms, also, were rather numerous during this period, and three small tornadoes were recorded, one at Tauranga and two in North Taranaki.

On the 28th a somewhat similar weather sequence set in. A shallow depression from the Tasman Sea gradually deepened, and, passing through Cook Strait, was centred east of Kaikoura on the 30th. Again a series of westerly depressions moved into this centre, and with each one the pressure over New Zealand fell further. The winds fluctuated between north-west and south-west as the depressions passed, and became strong. Temperatures fell with each southerly change, and there were numerous hailstorms and much snow on the ranges. This weather sequence did not terminate until the 2nd May. Rain was general on the 29th and 30th April.

RAINFALLS FOR APRIL, 1936, AT REPRESENTATIVE STATIONS.

Station.	Total Fall.	Number of Wet Days.	Maximum Fall.	Average April Rainfall.	Total Rainfall to Date.	Average Rainfall to Date.
	Inches.		Inches.	Inches.	Inches.	Inches.
North Island.						
Kaitaia	2·14	15	0·34	4·42	22·41	14·96
Russell	5·77	18	1·81	4·25	51·12	13·77
Whangarei	3·46	17	1·22	4·93	32·55	17·18
Auckland	2·72	15	0·60	3·88	21·36	13·69
Hamilton	5·38	12	1·07	3·85	24·52	14·09
Rotorua	4·11	11	0·94	4·41	31·13	15·91
Kawhia	5·32	9	1·10	4·65	21·44	14·48
New Plymouth ..	6·18	11	1·28	4·59	22·97	16·39
Riversdale, Inglewood ..	7·64	12	1·73	8·11	36·57	28·69
Whangamomona ..	11·46	10	2·03	6·52	29·93	20·97
Hawera	3·89	8	0·96	3·48	18·23	12·40
Tairua	5·13	20	1·27	5·96	26·96	19·51
Tauranga	4·31	16	1·32	4·70	28·38	16·43
Maraehako Station, Opotiki	5·98	10	1·78	4·74	30·42	16·43
Gisborne	2·86	11	1·22	4·05	23·51	14·65
Taupo	3·55	12	0·63	3·60	22·90	12·85
Napier	2·64	14	1·05	2·36	25·85	9·98
Hastings	2·60	13	0·93	3·33	24·51	10·27
Whakarara Station ..	4·10	11	1·10	..	30·19	..
Taihape	2·39	10	0·41	2·78	20·56	10·97
Masterton	2·67	12	0·94	3·05	20·13	11·14
Patea	4·10	10	0·68	3·67	19·82	13·01
Wanganui	3·63	10	0·74	3·27	18·65	10·99
Foxton	3·86	11	1·17	2·50	17·97	8·69
Wellington	3·33	12	0·70	3·64	21·21	12·48
South Island.						
Westport	6·86	17	1·36	8·25	20·30	29·30
Greymouth	7·57	15	1·27	8·48	26·15	32·66
Hokitika	7·15	15	1·24	9·46	24·91	36·29
Ross	7·63	11	2·16	12·18	30·35	44·21
Arthur's Pass	11·83	13	3·25	15·42	32·65	52·63
Okuru, South Westland	11·17	9	2·62	14·12	46·18	50·52
Collingwood	..	..	..	8·15	..	25·81
Nelson	3·08	11	1·29	3·10	11·29	11·55
Spring Creek, Blenheim	4·53	10	1·18	2·12	14·33	8·50
Seddon	2·51	9	0·94	1·71	12·78	7·40
Hanmer Springs ..	2·66	10	0·94	3·37	25·18	13·84
Highfield, Waiau ..	1·90	10	0·37	2·60	20·35	11·02
Gore Bay	1·82	9	0·48	2·38	17·43	9·77
Christchurch	2·87	13	0·91	1·75	17·12	7·48
Timaru	1·11	5	0·48	1·57	15·43	7·91
Lambrook Station, Fairlie	1·43	8	0·59	1·97	13·05	8·55
Benmore Station, Clearburn	3·13	13	0·91	2·40	7·89	9·20
Oamaru	1·04	7	0·55	1·79	13·60	7·40
Queenstown	4·20	11	1·71	3·08	11·40	10·54
Clyde	1·12	6	0·71	1·45	4·44	5·85
Dunedin	1·68	9	0·73	2·77	17·89	11·79
Wendon	3·05	6	1·90	2·71	11·65	10·91
Balclutha	1·86	6	1·08	2·19	9·28	8·80
Invercargill	2·73	17	1·32	4·24	14·03	15·31
Puysegur Point ..	8·98	18	1·61	7·67	28·69	29·00
Half-moon Bay ..	3·80	17	1·53	5·10	13·11	19·37